

SUMMARY OF  
**RESEARCH**

ACADEMIC DEPARTMENTS

OCTOBER 1995



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OFFICE OF THE ACADEMIC DEAN  
**UNITED STATES NAVAL ACADEMY**

ANNAPOLIS, MARYLAND

**SUMMARY  
OF  
RESEARCH**

**1994-1995**

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**OCTOBER 1995**

**UNITED STATES NAVAL ACADEMY**

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# Foreword

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This Summary of Research presents a listing and description of the research activity and productivity of the civilian and military faculty, and midshipmen at the United States Naval Academy for the 1994 - 1995 academic year. A total of 3.3 million dollars in research funding arrived in our institution. The funding categories break down into 11% provided from Naval Academy assets, 89% reimbursable, Navy providing 71%, DoD 5%, Federal 8%, and private 5%.

The Chief of Naval Research, Naval Surface Warfare Center, Naval Research Laboratory, and Naval Space Command are the primary Navy sponsors of faculty and midshipmen research. In the Federal category, the National Science Foundation and the Department of Energy have been the main sources of funding.

Midshipmen activities in research at the Naval Academy continued with students participating in independent research courses and honors projects. Twelve members of the Class of 1995 completed the Trident Scholar Program during this academic year. Their research achievements included the development of an operational global ocean climatology, a study of lift/drag forces in the deployment of an array of cylinders as a mine countermeasure technique, an exploration of the use of modern imaging systems to handle firearms identifications, and a study of the

characterization of the African-American male in literature published in the last two decades by African-American women. Midshipman Wesley Allen Hildebrandt, whose Trident project was supervised by Associate Professor Andrew T. Phillips of the Computer Science Department, was awarded the Harry E. Ward Trident Scholar Prize for his outstanding work on his project titled "Optimization of Linearly Constrained Indefinite Functions".

During this academic year the Naval Academy hosted several workshops. Among them was the workshop on "Faculty Study of Intelligent Computer-Assisted Instruction", which was funded by the Office of Naval Research. Thirteen faculty members carried out this study with external experts in ICAI in assessing the feasibility of this medium as a teaching tool at college level education. Six faculty members have been subsequently funded by ONR to work with external principal investigators in testing ICAI at the Naval Academy.

Research at the Naval Academy continues to play a key role in maintaining an atmosphere of scholarship in which midshipmen are exposed to the technical needs of the Navy as well as experience problem solving, an important ingredient of our teaching mission.



ROBERT H. SHAPIRO  
Academic Dean and Provost



REZA MALEK-MADANI  
Director of Research and Scholarship

# Contents

FOREWORD .....	ii
DIVISION OF ENGINEERING AND WEAPONS	
Aerospace Engineering Department .....	2
Electrical Engineering Department .....	8
Mechanical Engineering Department .....	18
Naval Architecture, Ocean and Marine Engineering Department .....	46
Hydromechanics Laboratory .....	68
Weapons and Systems Engineering Department .....	72
DIVISION OF HUMANITIES AND SOCIAL SCIENCES	
Economics Department .....	84
English Department .....	94
History Department .....	105
Language Studies Department .....	115
Political Science Department .....	130
DIVISION OF MATHEMATICS AND SCIENCE	
Chemistry Department .....	143
Computer Science Department .....	162
Mathematics Department .....	171
Oceanography Department .....	195
Physics Department .....	207
DIVISION OF PROFESSIONAL DEVELOPMENT	
Leadership and Law Department .....	225
INDEX OF CONTRIBUTORS	
Faculty .....	233
Midshipmen .....	236
DISTRIBUTION LIST .....	239



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**Division of  
Engineering and Weapons**

# Aerospace Engineering

Professor Mado Saarlus  
Chair

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Faculty and midshipmen research in the Aerospace Engineering Department covers many of the areas of specialization in aerospace engineering, ranging from unmanned low-speed aircraft (RPV) to communication problems with space shuttles.

Research is supported mainly through funds from government agencies such as the National Air and Space Administration, the Naval Research Laboratory, the Naval Air Warfare Center, and the Naval Space Command. The Naval Academy Research Council

provided laboratory matching funds for faculty research during the summer intersessional. This sponsored research provides benefit to its various sponsors and keeps the faculty current in state-of-the-art engineering practice. In addition, faculty participation in current development and research in the field of aerospace engineering has enhanced the learning process in the classroom, from the most fundamental courses to the final capstone design course.

## Sponsored Research

### Use of Computers in Spacecraft Design

Researcher: Professor William J. Bagaria  
Sponsor: Naval Space Command

Over the last several years, efforts have been underway to bring the computer aided design programs into the classroom as a design tool for the midshipmen. These programs are complex and run on engineering

workstations. The purpose of this research is to determine the most usable programs for the classroom environment, and to produce tutorial materials for use by the midshipmen.

### Wing Design for Very High Altitude Flight

Researchers: Professor Bernard H. Carson and Midshipman 1/C David J. Faehnle, USN  
Sponsor: Naval Research Laboratory

Wind tunnel tests were performed on a low-speed airfoil section developed by Naval Research

Laboratory. This study included the effect of various end plates of various geometries.

### Effects of Leading-Edge and Trailing Edge Flap Oscillations on the Aerodynamic Response of an F-18 Wing Model

Researchers: Associate Professor Gabriel N. Karpouzian,  
Ensign Dan Gordon, USN and Ensign Peter McArdle, USN  
Sponsor: Naval Air Warfare Center

An F-18 wing model has been built at the Naval Academy with leading-edge (LE) and trailing-edge (TE) flaps which are allowed to oscillate at various frequencies and amplitudes in and out of phase in order to study their effect on the aerodynamic response. The

preliminary work consisted of calibrating the balance system measuring instruments to read the loads and torques applied to the wing. Although there are six strain gages installed on the balance system to measure the three components of forces and three components

of moments, the initial calibration made was based on measuring the lift, drag, and pitching moment only. Wind tunnel tests were conducted to measure the lift, drag and pitching moment for steady mode (the wing LE and TE held at fixed positions) to establish the baseline for comparison with the unsteady (oscillatory) modes. The preliminary results indicate that enhancement of lift-to-drag ratio at some moderate LE

flap oscillations is possible. However, extensive parametric studies are required to understand what combinations of parameters such as frequency, amplitude, and phase will enhance the aerodynamic performance of the F-18 wing. Also it is imperative that the calibration be extended to include all the rest of components not accounted for in this initial phase of investigation.

### **Alternative Materials for Shipboard Fluid System**

Researcher: Assistant Professor Michael D. A. Mackney  
Sponsor: Naval Surface Warfare Center  
Carderock Division, Annapolis, Maryland

The objects of this study were various and included a literature search of standards and regulations for the design of duct systems for both US and UK warships and new technology composite materials applied to general ship design. A second objective was to discuss innovative designs with industry and shipbuilders, leading to the objective of examining fabrication techniques and design improvements for incorporation by shipyards.

By examining the existing US and UK warship design standards for heating, ventilation, and air-conditioning systems, a level of design quality was found, enabling the opportunity to adopt new technology to be established. Following discussions with industry and shipbuilders, the reasons for current design practices and fabrication techniques were elucidated, and the potential for difficulties arising from new technology was revealed. The importance of hazards due to fire, resulting in a variety of potential problems with new materials, which do not exist with current conventional constructional materials, is the

most important issue to be resolved, and is the initial selection factor for new materials. The ability to incorporate both acoustic and thermal insulation into a single product negates the need for additional ship fitting which is labor intensive, and has its own risks. However, the added complexity of fabricating such units in shapes and sizes compatible with ship fitting layouts, demands standardization of duct shapes and sizes, and more considerate design approach when doing system and compartment general arrangements. Tremendous advantages in reducing maintenance difficulties and costs as well as providing better ducting systems can only be assessed as beneficial when life costs becomes the deciding factor rather than the initial building costs. Philosophical differences between discipline such as shipbuilding, aerospace and architectures must be reconciled if the potential benefits, already accepted in one, are to be applied to others, particularly in the assessment and management of risk.

## **Independent Research**

### **Removal of Hip Femur Prosthesis**

Researcher: Professor William J. Bagaria

As hip joint replacement becomes more common, it has been discovered that about 10% of the prostheses have to be removed and replaced within ten years. When the prosthesis is first implanted, every effort is made to insure that it will not loosen. This in turn makes it very

difficult to remove it, if this becomes necessary. This project involved the pullout testing of hip replacement femoral prosthesis. The research was a joint project with the Walter Reed Army Medical Center.

## **Vehicle Tripping in Steady State Turns**

Researcher: Professor William J. Bagaria

Several rollover metrics, such as Static Stability Factor, Tilt Table Ratio, and Slide Pull Factor, are used to rank vehicles as to their rollover propensity. In certain applications, such as steady state cornering for vehicles with moderate to high centers of gravity, these metrics can be used to predict rollover speeds in situations in which they do not apply. These metrics cannot be used in the transient cornering case, where the lateral

acceleration changes suddenly compared to the body roll rate, neither for vehicles with low centers of gravity, nor those with "wide" tires compared to the vehicle half-track-width. This research involves the comparison of transient rollover speeds, as predicted by computer simulations to those predicted by the rollover metrics.

## **Effects of Leading-Edge and Trailing Edge Flap Oscillations on the Aerodynamic Response of an F-18 Wing Model**

Researchers: Associate Professor Gabriel N. Karpouzian,  
Ensign Dan Gordon, USN and Ensign Peter McArdle, USN

An F-18 wing model has been built at the Naval Academy with leading-edge (LE) and trailing-edge (TE) flaps which are allowed to oscillate at various frequencies and amplitudes in and out of phase in order to study their effect on the aerodynamic response. The preliminary work consisted of calibrating the balance system measuring instruments to read the loads and torques applied to the wing. Although there are six strain gages installed on the balance system to measure the three components of forces and three components of moments, the initial calibration made was based on measuring the lift, drag, and pitching moment only. Wind tunnel tests were conducted to measure the lift,

drag and pitching moment for steady mode (the wing LE and TE held at fixed positions) to establish the baseline for comparison with the unsteady (oscillatory) modes. The preliminary results indicate that enhancement of lift-to-drag ratio at some moderate LE flap oscillations is possible. However, extensive parametric studies are required to understand what combinations of parameters such as frequency, amplitude, and phase will enhance the aerodynamic performance of the F-18 wing. Also it is imperative that the calibration be extended to include all the rest of components not accounted for in this initial phase of investigation.

## **Research Course Projects**

### **Approximate Analysis for Buckling of Composite Plates**

Researcher: Midshipman 2/C Sean P. Boles, USN  
Adviser: Assistant Professor Oscar Barton

Techniques used to analyze mechanical behavior of symmetric composite laminates has dominated by numerical techniques. An alternative approach is the development of approximate closed form solution using sensitivity analysis.

Sensitivity analysis has been successfully implemented to develop approximate closed form expression for the buckling of rectangular symmetric

angle-ply laminates for various combinations of clamped and simply supported plates. These expressions cannot be used directly for repeated buckling loads.

This project seeks to develop a subroutine that removes the singularity corresponding to repeated buckling loads using a similarity transformation.

## **NanoSat Design**

Researcher: Midshipman 1/C Daniel N. Deciechi, USN  
Advisers: Robert E. Bruninga and Major Robert L. Dudley, USAF

The Naval Academy uses the Global Position Satellite System for tracking its boats on summer cruise in the Atlantic. A simple beacon transponder satellite is needed to reliably relay these position reports back to the Naval Academy. This design project concentrated on making the satellite as small as possible to improve its chances of deployment from the shuttle as a space available payload. Studies suggest the GPS beacon

transponder could fit in a satellite about the size of a softball. The thermal and lifetime analysis of such a satellite were the focus of this project. The report concludes that by making the satellite as dense as possible, that a 1.5 year lifetime could be achieved. The thermal balance of the spacecraft could be achieved within acceptable margins with suitable coatings.

## **Wing Design for Very High Altitude Flight**

Researcher: Midshipman 1/C David J. Faehnle, USN  
Adviser: Professor Bernard H. Carson

Wind tunnel tests were performed on a low-speed airfoil section developed by Naval Research

Laboratory. This study included the effect of various end plates of various geometries.

## **Water Propulsion Rocket Engine Design**

Researcher: Midshipman 1/C Elizabeth Scoonover, USN  
Advisers: Robert E. Bruninga and Major Robert L. Dudley, USAF

The Naval Academy uses the Global Position Satellite System for tracking its boats on summer cruise in the Atlantic. A simple beacon transponder satellite is needed to reliably relay these position reports back to the Naval Academy. Any such satellite launched on the Space Shuttle must have a rocket engine to achieve a higher orbit after deployment, but such an engine would have to meet the very stringent safety requirements of the manned space program. This design project concentrated on the design and testing of

a Hydrogen/Oxygen fueled engine with the gases derived from water by electrolysis. During transport by the shuttle, only water is on-board the spacecraft. Once deployed, electricity from the solar panels is used to generate the gasses for the engine. During multiple test firings, the current design has a propensity for an unstable combustion impulse instead of a smooth flow. Further work on the chamber pressure and fuel flow are required.

## **USNA Satellite Telemetry System Design**

Researcher: Midshipman 1/C Matthew A. Seen, USN  
Advisers: Robert E. Bruninga and Major Robert L. Dudley, USAF

The Naval Academy uses the Global Position Satellite System for tracking its boats on summer cruise in the Atlantic. A simple beacon transponder satellite is needed to reliably relay these position reports back to the Naval Academy. This design project focused on the power system, communication protocols, and the use of magnetorquing for controlling spacecraft attitude. Attitude control was required since the

satellite would have a propulsion system to raise it from the Space Shuttle deployment altitude to a higher orbit. Experiments were conducted with the AX.25 communications protocol and calculations were conducted on the solar panel, the battery system, and the power required to produce a torque in the earth's magnetic field.

## **Interactive Computational Fluid Dynamics Demonstration: MacCormack's Technique Applied to Quasi-1D Isentropic Flow**

Researcher: Midshipman 1/C Paul L. Wynns, USN  
Adviser: Post Doctoral Charles Lind

The objective of this Computational Fluid Dynamics (CFD) demonstration is to provide an introductory guide to the principles of CFD. The user, through hypertext menus, is allowed the opportunity to explore the computational, numerical, and thermodynamic phenomena associated with a conservative computed solution to isentropic flow in a quasi 1D nozzle. The basic aspects of CFD are presented, including: initial

conditions, boundary conditions, stability criteria, shock-capturing, and artificial viscosity. Throughout the demonstration, an emphasis is placed on simplicity. The presentation is geared towards introducing CFD without the formality of programming techniques. Thus the principles presented can be applied to any numerical solution on any operation system/computer language.

## **Publications**

KARPOUZIAN, Gabriel N., Associate Professor, Coauthor, "Comprehensive Model for Anisotropic Composite Aircraft Wings Suitable for Aeroelastic Analyses," *Journal of Aircraft*, Vol. 31, No. 3 (May-June 1994), 703-712.

A comprehensive plate-beam structural model suitable for aeroelastic analyses of aircraft wings made of anisotropic composite materials is developed. The equations governing the static and dynamic aeroelastic equilibrium of cantilevered swept-wing structures and the associated boundary conditions are derived by means of the Hamilton variational principle. These equations incorporated a number of effects: anisotropy of the materials of constituent layers, warping inhibition, transverse shear flexibility, and rotary inertias. A uniform swept-wing model composed of a transversely isotropic material is considered to illustrate the coupled and separate effects of transverse shear deformation and warping restraint upon its divergence and static aeroelastic load distribution. An exact method based upon the Laplace integral transform technique is used to solve the above mentioned problems. The results displayed in this article reveal the importance of transverse shear and warping restraint effects in predicting more accurately the static aeroelastic response of swept-forward wings. However, for swept-back wings, these effects represent higher-order corrections to the classical theory.

MACKNEY, Michael D. A., Assistant Professor, "An Initial Study of Alternative Materials for Shipboard Fluid Systems," USNA Report EW-03, March 1995.

An initial study of alternative materials for shipboard

fluid system, particularly heating, ventilating and air conditioning systems has been undertaken which shows that composite materials based on phenolic resins and intumescent foamed cores or polyamide cores could provide suitable replacement for steel based ducting systems which are very liable to corrosion, and require extensive insulation. Development work presently in the off shore industries or aerospace industries can be developed for marine applications.

The clear choice of non-metallic materials while holding advantages in weight longevity, and non-corrosiveness, have fabrication differences which make retraining of fabrication personnel essential. Fire resistance can be incorporated into sandwich composite construction by suitable choice of resins and primary materials.

The existing naval ship design regulations established over many years of experience working with conventional metallic materials contain extensive details which are inappropriate for new technology materials, and such standards are being rewritten to provide less restriction on the designer.

A number of companies and organizations both in the United States and the United Kingdom were contacted, and many were visited. Such companies had expertise in material development for related or unrelated industries, which was clearly applicable to warships.

Since little standardization of duct size or shape exists at present, and much unique fabrication takes place with existing thin sheet metallic materials, there is a primary need for standardization of duct work and fittings in non-metallic materials, which allows minimum on-site fabrication, with maximum confidence that parts can be assembled into leak proof

systems. Existing technology such as filament winding is suitable for circular or rectangular duct sections as a single uninsulated skin, or as a sandwich construction, pre-insulated, duct section. Although it is possible to fabricate duct sections from flat sheet composite material, development work is needed to produce a jointing system which is simple to apply with existing fabrication skills.

It is recommended that the study should continue to examine sandwich construction ducts, and to propose standard sizes and selected fittings to make the task of shipboard installation easier. It is also proposed that a complete prototype assembly is tested in a laboratory environment before a shipboard prototype system is installed, with life term costs being assessed.

ROGERS, David F., "The Possible "Impossible" Turn," AIAA Journal of Aircraft, Vol. 32, No.2, March-April 1995, 392-397.

Turning back after engine failure during the takeoff phase of flight in a single engine aircraft is examined using a simplified analytical model. The important parameters are identified. The analysis shows that the optimum flight path is teardrop-shaped with a 45-deg bank angle at stall velocity during the turn. The effects of engine failure altitude, wind direction and velocity, climbout velocity, bank angle, and velocity in the turn on the required runway length are examined. The results show that the typical recommendations for general aviation single engine aircraft are not optimum.

## Presentations

KARPOUZIAN, Gabriel N., Associate Professor, "Exact Flutter Solution of Advanced Composite Swept Wings in Various Flight Speed Regimes," 36th Structures, Structural Dynamics and Materials Conference, New Orleans, Louisiana, 10-12 April 1995.

ROGERS, David F., Professor, Short Course "Introduction to Nurbs," Computer Graphics International 94, RMIT Melbourne, Australia, June 1994.

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# Electrical Engineering

Colonel James F. Kendrick, USAF  
Chair

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**R**esearch and scholarly activity are fundamental to the vitality and viability of any discipline. This is particularly applicable to electrical engineering, which is broadly based and rapidly expanding. Research helps both faculty and midshipmen keep abreast of advancing technology and ultimately improves the effectiveness of the academic environment by encouraging a modern and relevant curriculum.

Funding for our research comes from the Naval Research Laboratory, the Naval Surface Warfare Center, The Naval Air Warfare Center, and from within the Naval Academy. Research topics supported during the past year included Microwave Furnace Processing

and Dielectric Property Measurement of Materials, IR Sensor Evaluation, Gain Dispersion in Microelectronic Devices, Remotely Operated Underwater Vehicles, Shipboard Electrical Distribution Stability, Shipboard Equipment Design and Fault Diagnosis, Electro-optics and Optical Signal Processing, Fuzzy Neural Systems, Scattering and Spectral Estimation Techniques Applied to the Cochlea. This faculty research contributes directly to the fleet's operational capabilities and provides relevant topics which benefit the professional as well as the academic development of our midshipmen.

## Sponsored Research

### Initial Operation of a 6 KW, 2.45 GHz Single-Mode Microwave Cavity Furnace

Researcher: Assistant Professor Ralph W. Bruce  
Sponsor: Naval Research Laboratory

The primary purpose of this study was to put together a single-mode microwave cavity furnace system operating in the  $TE_{103}$  mode at a frequency of 2.45 GHz. While assembling this system, various operating parameters such as forward and reverse power levels had to be obtained which required the acquisition and integration of power sensors and associated hardware. Initial sintering experiments were conducted on compacted nanocrystalline metal-oxide ceramic powders. As time allowed, dielectric characterization of the powders and sintered compacts at elevated temperatures was to be explored. Additionally, physical characterizations such as x-ray diffraction, porosity, density, etc., were conducted on both the powders and sintered materials.

A single-mode cavity microwave furnace, operating in the  $TE_{103}$  mode at 2.45 GHz, has been set up at the Naval Research Laboratory and is being used to investigate sintering of metal-oxide nanocrystalline ceramics. Currently, this furnace is being used to sinter

high purity nanocrystalline  $Al_2O_3$  (Alumina) and  $TiO_2$  (Titania). These powders were derived using the sol-gel method. They were first uniaxially pressed to 2000 psi, CIP'ed to various pressures  $\geq 20$  Ksi and finally sectioned into wafers. The density of the green wafers was 30 to 35%. The wafers were heated in the microwave furnace for up to two hours at temperature  $\leq 1700^\circ C$ . The temperature of the work piece was monitored using an optical pyrometer. Final densities up to 80% TD have been obtained to date for  $Al_2O_3$  and up to 52% TD for  $TiO_2$ . Work is ongoing to characterize the sintered compacts, optimize the casketing for the furnace, and lay the groundwork for new studies using a gyrotron at 35 GHz and a quasi-optical gyrotron tunable from 85 to 120 GHz. Additional work is continuing on instrumentation for the measurement of high temperatures in high powered microwave fields. Dielectric characterization of the powders and sintered compacts at high temperatures is also being developed.



## **Neural Network IRST Track Evaluation and Sensitivity Study**

Associate Professor David S. Harding

Sponsor: Naval Air Warfare Center, Warminster, Pennsylvania

Data from aircraft based infra-red sensors is used to detect and track potential threats and targets. Currently a Bayesian evaluator is used to sort actual targets from clutter. The Bayesian IRST (infra-red search and track) track evaluator can yield a false alarm rate which is higher than desirable under some conditions. A neural network can also be trained to perform evaluation of IRST data. For this work, the data used to develop and evaluate a neural net alternative was obtained from Naval Air Warfare Center. The task of the evaluator is to classify associated detections as either target tracks or clutter tracks. Once a viable neural network has been successfully trained and tested it must be evaluated for sensitivity to expected variations in input parameters. Noise can degrade the quality of the neural network input parameters and pulse-like changes may also occur when a target is moving behind clouds or other clutter.

A three layer feed forward, back propagation neural network was chosen because of the availability of distinctive training sets for supervised training. To represent the dimension of time, that is, to represent the "shape" of a track, track parameters from multiple frames are combined and presented simultaneously to the input of the network. Two neurons (processing elements) are used in the output layers of each network. One output neuron is used to

represent target detection and one to represent clutter.

A subset of roughly half the data is used for supervised training of a network being developed and the other half reserved for network testing. The content of the training subset is varied to optimize results. Two trained networks are used rather than one. One of the two is trained on data gathered above the horizon and the other trained on data from below the horizon. Successful training has been achieved for a variety of different training mixes. Successful training means zero errors for the training mix. As the training mix is made more representative of the global data, the rate of errors made by the neural network on test data decreases. A training mix has been found for which the error rate on the data reserved for test is close to zero. The trained neural network also achieves a false alarm rate significantly lower than the current IRST Bayesian track evaluator. The sensitivity of a trained network to expected variations in the track parameters has been investigated for the above the horizon case. Both pulse and noise variations are examples of the type of parameter contamination which might be expected. Preliminary results show significant tolerance of a trained network to both pulse and noise contamination of track parameters. The sensitivity study needs to be continued for the below the horizon case.

## **Investigation of HEMT Gain Dispersion**

Research: Assistant Professor Duane G. Keye

Sponsor: Naval Research Laboratory

Gain dispersion is a phenomenon that occurs due to available energy states in the forbidden gap in semiconductor material. These energy states are called traps. The effect of traps on gain can be seen as frequency is varied. The objective of the research is to measure gain as a function of frequency, from that data model and estimate the energy levels of the traps, and

correlate the trap levels with the material's growth parameters.

As this is a new project, major effort has been devoted to researching past efforts and publications, and becoming familiar with the equipment and its capabilities.

## **Underwater Hull Inspection of Naval Ships Using a Remotely Operated Underwater Vehicle**

Researcher: Assistant Professor K.A. Korzeniowski

Sponsor: Naval Surface Warfare Center, Annapolis, Maryland

The purpose of the Ship Husbandry, Remotely Operated Underwater Vehicle Project, is to determine the condition of a ship's hull without bringing it into

dry dock. Presently, ships are brought into dry dock on a regular basis. This represents a considerable expense to the Navy. The purpose of the underwater vehicle

inspection is to determine when dry docking is truly necessary and also to insure that the hull integrity is maintained between dry docking.

Currently work is in progress to integrate sensors in the remote operated vehicle (ROV) system. The sensors include, paint thickness, plate thickness and surface

roughness. A linear and rotary actuator robotic system will be used to position the sensors on the hull of the ship so that measurements can be made. Further work will involve fusing the sensor data so that the data may be interpreted. This work will continue through the summer of 1995.

### **Stability Analysis of the DC Combat System with Constant Power Load**

Researcher: Professor Richard L. Martin

Sponsor: Naval Surface Warfare Center, Annapolis, Maryland

Many of the electrical loads associated with the U.S. Navy ship DC combat systems are required to draw a fixed amount of power even as the system voltage varies. These loads then appear as negative resistance loads, which causes concern for the dynamic stability of the overall power distribution system. The stability analysis done here was composed to two parts. Analysis of the system in the frequency domain was performed through manipulation of the voltage transfer function which resulted in a classical control system analysis of the ratio of load impedance to the source

impedance  $Z_L/Z_S$ .  $Z_L$  consisted of a dynamic load impedance -  $R_L$  with a shunt capacitance, with a series resistance and capacitance also in shunt with the load, to better approximate the filter for the constant power combat load.  $Z_S$  consisted of a series  $R+L_s$ . Nyquist diagrams were used to demonstrate the accuracy of the "better" model. Linear approximations for the different level input filters and linear negative resistance (constant power) load models were simulated using the advanced computer stimulated language (ACSL) program.

### **Motor Current Signal Analysis for Diagnosis of Fault Conditions in Shipboard Equipment**

Researcher: Professor Antal A. Sarkady

Sponsor: Naval Surface Warfare Center, Annapolis, Maryland

The detection and diagnosis of faults in Navy shipboard equipment requires a large investment in man-hours and money. The diagnosis of machinery problems often requires that equipment be shut down and taken apart. In addition, the machinery may be located in an area of the hull that is very difficult to reach. Motor current signature analysis can provide a solution to some of these problems. It is a non-invasive technique for monitoring and diagnosing mechanical problems in motor driven equipment. The aim of this research work is to develop motor current signal processing and classification techniques used to distinguish between the normal and eroded impeller

conditions of a submarine sea water pumps. During 1993-1994 signal processing and classification algorithms were developed and successfully applied to a Byron Jackson sea water pumps operating under laboratory conditions with good impellers and with eroded impellers. The results of our research clearly shows that it is possible to distinguish between the pump working with a good impeller and the pump working with an eroded impeller using motor current analysis. In the spring of 1995, two papers were published on our research findings. Presently, our Navy is collecting motor current data from working submarines which will be analyzed shortly.

### **Optical Signal Processing.**

Researcher: Captain Christopher. C. Foster, USMC

Sponsor: Naval Research Laboratory

This project is my doctoral research, for programs at both the Naval Postgraduate School and the University of Maryland, College Park. This research is focused on the development of Integrated Optical Signal

Processors capable of performing Real Time Auto-Correlations and Cross-Correlations of RF signals and providing Higher-Order statistical analysis in a real-time environment.

# **Independent Research**

## **Electro-Optic Probing of GaAs and INP**

Researcher: Assistant Professor Deborah Mechtel

Non-invasive methods are important for testing high speed microwave circuits with sensitive characteristics that are easily disturbed by standard invasive test instrumentation. We have built a non-invasive laser based probing instrument to characterize microwave circuits fabricated on GaAs and InP.

The electro-optic probing instrument relies on either a continuous wave (CW) or pulsed semiconductor diode laser to test circuits. The method is based on phase modulating a laser beam with an electro-optic semiconductor such as GaAs to measure

the electric field intensity and voltage at locations on the microwave circuit. A unique advantage of the electro-optic probing instrument is the ability to make voltage measurements throughout the circuit in a manner similar to traditional probing instruments but without the parasitic loading normally experienced by the circuit. Electro-optic probing may be utilized in the GHz range and has a spatial resolution of approximately 1 micron. Present work is focused on calibrating the electro-optic probing instrument and increasing the speed of sampled circuits.

## **A CMOS PWL Fuzzy Membership Function**

Researchers: S. Ahmadi, Assistant Professor Louiza Sellami,  
and Robert W. Newcomb

The membership function, classically constructed from piece-wise linear (PWL) functions, is one of the most important components in fuzzy neural systems. Here we give an improved current mode complementary metal oxide semiconductor (CMOS) circuit suitable for design of fuzzy membership PWL functions. The

circuit with bidirectional input is based upon an improved current mirror and is suitable for very large scale integration (VLSI) fabrication via the metal oxide semiconductor integration system (MOSIS) CMOS process.

## **Spectral Estimation in a Digital Cochlea Model**

Researchers: Assistant Professor Louiza Sellami  
and Robert W. Newcomb

A digital scattering cochlea model that simulates Kemp echoes, in their impulse response, and from which a characterization of the cochlea can be made, is presented. The transfer function of the cochlea is

estimated through Youla's auto-regressive moving average (ARMA) system identification technique, and its spectrum is compared to that of Kemp echoes recorded from human ears.

## **A Digital Scattering Model of the Cochlea**

Researchers: Assistant Professor Louiza Sellami  
and Robert W. Newcomb

A cascade digital scattering linear model of the cochlea, suitable for Kemp echo cochlea characterization, is developed. This model is a unidimensional transmission line model to which nonuniform and loss properties are added. Its lattice structure is obtained by rephrasing the model equations in terms of incident and

reflected scattering waves. A characterization of the cochlea, through the estimation of the width, the stiffness, and the resistance of the basilar membrane, is made with the model and the results compared to data available in the literature.

# Research Course Projects

## Dielectric Properties Measurement of Materials

Researcher: Mid/n 1/C Bradley W. Busch  
Faculty Adviser: Assistant Professor Ralph W. Bruce  
Sponsor: EE Department

This project will produce and/or verify fundamental data on the dielectric properties of materials. Part of the project will be to verify the accuracy of the test instruments by comparison of results with established studies. This will produce a basis for ascertaining the reliability of data for subsequent materials that have not been measured over these frequency ranges and temperatures.

A measurement system consisting of the HP 8722C Vector Automatic Network Analyzer, recirculating hot/cold temperature bath (using ethylene

glycol as the working fluid) and appropriate temperature sensors has been assembled. Using the dielectric probe kit obtained with the network analyzer, measurements have been made on a number of organic solvents, e.g., methanol, ethanol, and isopropanol, in the frequency range of 100 MHz to 24.1 GHz and over the temperature range of -20°C to 60°C. The results obtained to date are being compared with established data to determine the effectiveness of the test methodology and the accuracy of the measurement system.

## Design Optimization of a Matrix-Converter AC to AC System

Researcher: 1/C Michael C. Lapaglia  
Adviser: Assistant Professor Brian K. Butka  
Sponsor: Naval Surface Warfare Center, Annapolis, Maryland

This project investigated the effects of a finite switching time on the performance of a matrix-converter AC to AC system. Using total harmonic distortion as a figure of merit, the tradeoffs between the number of samples per cycles and quantization error were examined. An optimum configuration of 384 samples per cycle and 42

discrete levels yields performance significantly superior to present designs. The optimum configuration is difficult to implement in hardware, so the tradeoffs necessary in simplifying the hardware also examined. This work will be presented by Midshipman Lapaglia and myself.

## Characterization of Integrated Optic Waveguides

Researcher: 1/C Matthew Kawas  
Adviser: Assistant Professor Brian K. Butka

This two semester effort focused on understanding the theory of integrated opto-electronics and the characterization of integrated optic waveguides and couplers. The integrated optic waveguides were obtained from Johns Hopkins Applied Physics Lab and had been previously analyzed by APL. The waveguiding performance was investigated for both

visible and far infra-red wavelengths. The waveguides were found to contain fabrication errors which limited the optical performance. The fabrication errors and characterization results were reported to Johns Hopkins as well as suggestions on possible improvements to the fabrication process.

## Robot Navigation of a Complex Environment Using Exteroceptive Sensors

Researcher: Midshipman 1/C Matthew J. Kawas  
Adviser: Asst Prof Kelly A. Korzeniowski and Professor Kenneth A. Knowles

The purpose of this project is to incorporate sensing ability in an overall robotic system so that a robot may be able to adapt its behavior to suit the environment. In

the first semester, Midshipman Kawas has developed controllers and algorithms to enable a robot to move around a maze using force feedback without prior

knowledge of the exact configuration of the maze. In the second phase of the project, the robot's sensing ability is increased by adding proximity sensors. Midshipman Kawas has also given the robot the ability to adapt to the environment by adding pressure transducers to the gripper of the robot and developing an algorithm that allows wrist compliance and variable

gripper pressures.

The work done by Midshipman Kawas is valuable because it can be included in the Robotics class currently given at the Naval Academy. This work is also well documented so that it can be continued through other independent senior research projects.

## Microprocessor Controlled Variable Bit-Length Pseudorandom Code Generator for Optical Fiber Communication

Researcher: Midn. 1/C Michael F. King

Adviser: Professor. Antal A. Sarkady and Captain Christopher C. Foster USMC

Sponsor: Naval Surface Warfare Center, Annapolis, Maryland

A spread spectrum communications system is currently being developed by the United States Navy to act as the backbone of the shipboard machinery monitoring and control, and damage control sensor networks. This research developed a microprocessor controlled, pseudorandom code generator which will be used to drive the optical sources for the fiber optic sensor systems. The design offers the flexibility of generating

pseudorandom bit sequences (PRBS) using seed lengths from 2 to 16 bits, and has a programmable interface that allows the bit length and the initial seed value to be user defined. The system operates at 25 MHz with a programmable pulse repetition time (PRT). An eleven page paper has been prepared on this research work and has been submitted to "The International Society for Measurement and Control" for publication.

## Publications

BRUCE, Ralph W., Assistant Professor, co-author, "Microwave Applications in Ceramic Processing," in Proceedings: Microwave Technology, 2000 and Beyond, University of Cincinnati, Cincinnati, Ohio, 29 September, 1994.

Recent work in the application of microwave technology to the processing (i.e., drying, sintering, etc.) of ceramics has shown that highly densified ceramics can be made using standard microwave components. The system configuration for these applications has been either the multimode or the single-mode cavity. Initial work being pursued at the Naval Research Laboratory has focused on the use of a 2.45 GHz single-mode cavity. A single-mode cavity with a variable iris, movable short and associated hardware has been assembled and tested in both the cold and hot modes. Ceramic materials such as alumina ( $\text{Al}_2\text{O}_3$ ) and Titania ( $\text{TiO}_2$ ) have been sintered using this apparatus. The purpose of this discussion will be to briefly describe the process of microwave sintering of ceramics, the material properties' data required to successfully accomplish this, and the system configuration needed to sinter ceramics more effectively and efficiently.

BRUCE, Ralph W., Assistant Professor, co-author, "Microwave Sintering of Nanocrystalline Ceramics",

Ceramic Transactions, (Microwaves: Theory and Application in Materials Processing), American Ceramics Society, Inc., Westerville, Ohio, 1995.

A single-mode cavity microwave furnace, operating in the  $\text{TE}_{103}$  mode at 2.45 GHz, has been set up at the Naval Research Laboratory and is being used to investigate sintering of oxide nanocrystalline ceramics. This presentation will discuss the apparatus used and the results obtained to date. The high purity  $\text{Al}_2\text{O}_3$  and  $\text{TiO}_2$  nanocrystalline powders were derived by the sol-gel method. These powders were first uniaxially pressed to 2000 psi, CIP'ed to various pressures  $\geq 20$  Ksi and finally sectioned into wafers. The density of the green wafers was 30 to 35%. The wafers were heated in the microwave furnace for up to two hours at temperatures  $\leq 1700^\circ\text{C}$ . The temperature of the work piece was monitored using an optical pyrometer. Final densities up to 80% TD have been obtained to date for  $\text{Al}_2\text{O}_3$  and u Optical Signal Processing.

BRUCE, Ralph W., Assistant Professor, co-author, "Initial Operation of a 6 KW, 2.45 GHz Single-Mode Microwave Cavity Furnace", NRL/MR/6793-7745.

Microwave processing of advanced ceramic materials is emerging as an important new technology with many advantages compared with conventional processing

techniques. These advantages include improved quality, new material properties, and faster processing. In conventional heating of ceramic materials, energy is applied at the surface of the work piece by flowing gas or infrared radiation and is transferred into the bulk of the material by conduction. This process is relatively slow (the processing time is usually measured in hours), often produces internal stresses in the material due to nonuniform heating, and is often accompanied by significant grain growth that reduces materials performance. In contrast, microwave heating deposits energy far more rapidly and volumetrically, and can result in little grain growth. On the other hand, since the microwave absorption rate is highly temperature dependent and the ceramic materials have low heat conductivity, the heating process is prone to temporal and spatial thermal runaway. In addition, microwave absorption of 2.45 GHz radiation, the frequency of conventional microwave ovens, is so low at room temperature for many ceramic materials that heating cannot be achieved without using hybrid (conduction + microwave) heating techniques. In order to investigate methods of overcoming these limitations, and to provide a basis for comparison with planned high frequency microwave heating experiments, an S-band 2.45 GHz microwave resonant cavity furnace operating in the  $TE_{103}$  mode has been set up at the Naval Research Laboratory (NRL). This memorandum describes the design and operating parameters of the microwave furnace and reports on preliminary sintering experiments carried out on green compacts of nanocrystalline alumina and titania.

BUTKA, Brian K., Assistant Professor, "Designing a High Frequency Current Controlled PWM Inverter for Loads with Widely Varying Power Factors," International Journal of Power and Energy Systems, 1994.

As the Navy designs the ships of the next century, power distribution systems are a major concern for ship survivability. One proposed distribution system distributes D.C. throughout the ship and a converter circuit then converts the power to the appropriate voltage and frequency directly at the power outlet. Since the power factor of the loads attached to an outlet are not controlled, this research develops a design technique for PWM inverters which are used over a wide variety of loads. The research investigates the performance of simple PWM algorithms without external control loops to improve performance. Component sizing and switching frequency tradeoffs are investigated and a design technique suitable for widely varying loads is proposed. Keywords PWM, Inverter, Power Electronics.

FOSTER C. C., Capt. This is my doctoral research, in

the Ph.D. Programs at both the Naval Postgraduate School and the University of Maryland, College Park.

This research is focused on the development of Integrated Optical Signal Processors capable of performing Real Time Auto-Correlations and Cross-Correlations of RF signals and providing Higher-Order statistical analysis in a real-time environment. Work is ongoing to characterize the sintered compacts, optimize the casketing for this furnace, and lay the groundwork for new studies using a gyrotron at 35 GHz and a quasi-optical gyrotron tunable from 85 to 120 GHz.

FOSTER C. C and P. E. Pace and, "Beam propagation analysis of a parallel configuration of Mach-Zehnder interferometers", Optical Engineering 33, No. 9, 2911-2919.

This paper developed an efficient and effective method for designing and analyzing the performance of various integrated optical waveguide structures using the beam propagation method of analysis. Modifications in the physical layout of an optical device through changes in coupling connection design, splitting angles and waveguide dimensions may have significant effects on device performance. The beam propagation method is initially developed for a symmetric Mach-Zehnder interferometer for baseline validation of the accuracy and applicability of the propagation scheme. A major validation is achieved through modeling an asymmetric device designed and built by the Naval Research Laboratory. The validated simulation model is used to analyze the performance and design characteristics of complex parallel configurations of interferometers. The beam propagation method allows quantitative analysis of the performance of these integrated optical devices. The propagation model developed implements a new global propagator scheme that substantially reduces computational requirements and introduces a design methodology that ensures compatibility between the discrete implementation and the physical structure. Also identified are areas in which continued research can provide a complete modeling system that may be implemented as a stand alone design and analysis tool.

FOSTER, C. C., and P. E. Pace, "Computer Simulation of Integrated Optical Devices", Scientific Computing, October 1994 pp. 19-22.

This Article focused on the Computational aspects of Computer Aided Design of Integrated Optical Devices.

KORZENIOWSKI, Kelly A., Assistant Professor, "Coordinating Robotic Sensors in a Complex Environment for Data Collection and Object Recognition", SPIE Vol. 2355 Sensor Fusion VII, October 1994, 25-32.

The objective of this work was to design control algorithms that would enable a multi sensor robotic system to perform specified tasks in a real world environment. The robotic system presented in this paper operates with little or no prior knowledge. There the robot is given the task of collecting information about its surroundings. Data may be collected for the purpose of object recognition, environment mapping or object manipulation. The main sensing capabilities chosen for this system are machine vision and tactile force sensing. Each sensing technique has its relative advantages and disadvantages. Therefore, the sensing techniques are coordinated. A camera is used to gather *global* visual information. An attempt is made to identify the object by computing a set of invariant moments from a 'chain code'. This is compared to information about models in a data base to narrow the scope of the recognition. This first guess at an identification is used to drive the active *local* tactile sensing. The information from the tactile sensors is dense and very accurate. After this stage, a final identification is made. Experiments are performed to show that the algorithms allow the system to meet the goals of safety, accuracy and economical use of computational resources.

KORZENIOWSKI, Kelly A., Assistant Professor, "Practical Electronic Instrumentation for All Engineering Disciplines", Frontiers in Education, June 1995.

True engineering is a multi discipline field. Whether one is primarily named electrical, mechanical, chemical etc. commonalities exist among all engineers. Environmental measurements must be made, conditioned, then converted for input into a computer so that these measurements may be interpreted by an algorithm. Therefore in the process of providing an engineering student with a rounded background of knowledge, electronic instrumentation should be included. This article describes the process of introducing electronic instrumentation to non electrical engineers.

LIM, Tian S., Professor, "Undergraduate Engineering Laboratory in Counter Design," 1994 ASEE, Annual Conference Proceedings, June 1994, 912-916.

This paper describes an undergraduate electrical engineering laboratory experiment at the United States Naval Academy. It details the design and implementation of two types of asynchronous counters: self-correcting ring counter and self-correcting Johnson counter.

SANTORO, R. P., Professor "Piecewise-Linear Modeling of I-V Characteristics with Spice," IEEE Transactions on Education, Vol. 38, no.2, 1995.

This paper presents a technique for piecewise-linear modeling of arbitrary nonlinear I-V characteristics with SPICE. In particular, I-V characteristics (including those exhibiting negative resistance) that lend themselves to piecewise linear approximation are easily modeled using six elemental building blocks; three for voltage-controlled I-V characteristics and three for current controlled I-V characteristics. The elemental building blocks are implemented with resistor, diode, independent voltage source, and independent current source SPICE primitives. Two of the elemental building blocks use the ability of SPICE to accept negative values for the resistance and diode saturation current parameters. The technique is applied to model a unijunction transistor and a tunnel diode. Two negative resistance oscillator examples which use these models are included; a current-controlled negative resistance sinusoidal oscillator (unijunction transistor) and a voltage-controlled negative resistance relaxation oscillator (tunnel diode). These examples have been used to teach the fundamentals of negative resistance oscillators and nonlinear effects to sophomores and juniors.

SELLAMI, L., S. Ahmadi, and R. W. Newcomb. "A CMOS PWL Fuzzy Membership Function," Proceedings of the IEEE International Symposium on Circuits and Systems, April-May 1995, pp 2321-2324.

The principle objective is to construct a piece-wise linear (PWL) function with arbitrary domain, range, and number of break points. Also, it is desired to be able to alter this PWL function by changing the slope of the linear segments, as well as the break points along the domain independently of each other. Furthermore, it is desired to be able to shift the entire PWL function to anywhere in the plane without changing its shape. The principle idea in constructing this PWL function is to algebraically superimpose several elementary functions together. These elementary functions are themselves PWL functions with only one break point which separate the function into two linear segments: a linear segment with zero slope and another one with nonzero slope.

SELLAMI, L., and Robert W. Newcomb, "Spectral Estimation in a Digital Cochlea Model," (in preparation) to be submitted to the International Journal of Simulation, The Netherlands.

To be able to use our digital model for cochlea characterization, its transfer function, assumed stable, minimum phase, and of unknown order, must be estimated. Kemp echoes, recorded from human ears and considered here as the impulse response of the cochlea, are employed as the output signal in a new ARMA system identification technique developed by Youla.

This technique is deterministic and utilizes the theory of positive-real and bounded-real functions, Richard's theorem, and the concept of degree reduction to estimate both the order and the predictor coefficients of a stable ARMA(n,m) filter with a minimum phase rational transfer function.

SELLAMI, L., and Robert W. Newcomb, "A Digital Scattering Model of the Cochlea," (in preparation) to be submitted to the IEEE Transactions on Circuits and Systems I.

This work continues studies initiated with P. Gomez and V. Rodellar, but differs in two essential ways from past research. First, the model itself is different in that it is of a scattering nature, i.e., based on incident and reflected pressure waves. Second, it extends our previous model which converts to a cascade of digital scattering lattice filters with each lattice now described by a transfer scattering matrix containing the characteristic parameters of that section of the cochlea. The advantage of the proposed model structure is that it simulates Kemp echoes in their impulse response and leads to a systematic cochlea characterization.

SARKADY, Antal A., Professor, "Motor Current Analysis for the Diagnosis of Fault Conditions in Motor Driven Pumps," Proceedings of the 49th Meeting of Society for Machinery Failure Prevention Technology, Virginia Beach, Virginia. April 18-20, 1995, 231-249.

The detection and diagnosis of faults in Navy shipboard equipment requires a large investment in man-hours and money. The diagnosis of machinery problems often requires that equipment be shut down and taken apart. In addition, the machinery may be located in an area of the hull that is very difficult to reach. Motor current signature analysis (MCSA) can provide a solution to some of these problems. It is a non-invasive technique for the monitoring and diagnosing of mechanical problems in motor driven equipment. This paper presents the development of a signal processing and classification techniques used to distinguish between the normal and eroded impeller conditions of a submarine sea water pump. Demodulation techniques

are presented for the extraction of relevant signal features used to create pattern vectors for classification. The ultimate goal of this research is to develop MCSA techniques which can be applied to a broad variety of shipboard motor driven machinery.

SARKADY, Antal A., Professor, "Motor Current Signal Analysis for Diagnosis of Fault Conditions in Shipboard Equipment," Naval Engineers Journal. January 1995, 77-98.

In the Navy it is imperative that systems and equipment work at their peak performance levels. Man-hours, money, and even lives may depend on it. On a submarine, it may even be more important, because fault conditions in equipment in equipment can lead to increased noise levels, and form a higher probability of detection by the enemy. There are inherent problems associated with detecting fault conditions in shipboard equipment. Most importantly, equipment must often be shut down, and taken apart. This can cost countless man-hours, and down time that an underway vessel cannot afford. In addition, the equipment may be located in an area that is very difficult or impossible to reach under normal circumstances. This would include all equipment found in the primary plant of a nuclear powered submarine.

Motor current signal analysis provided a solution to these problems. It is a non-invasive technique for monitoring and diagnosing mechanical problems associated with equipment driven by electrical motors. The objective of this project was to implement this process by (1) examining the electrical power signal supplied to a Byron Jackson main sea water pump found in a U.S. submarine and (2) to develop signal processing routines and classification techniques to distinguish between the pump working with a good impeller and the pump working with an eroded impeller. Although this one fault condition was studied, this research sought to develop a method by which other fault conditions could be detected.

Results of this study clearly shows that it is possible to identify and classify eroded impeller condition in a main sea water pump operating under normal conditions.

## Presentations

BRUCE, Ralph W., Assistant Professor, "Introduction and Basics of Wave-Materials Interactions," in Microwave Technology in Chemistry and Ceramics, Professional Development Course, Twenty-Ninth Microwave Power Symposium, Chicago, Illinois, 24 July 1994.

BRUCE, Ralph W., Assistant Professor, "Microwave Applications in Ceramic Processing," in Microwave Technology, 2000 and Beyond, University of Cincinnati, Cincinnati, Ohio, 29 September 1994.

BRUCE, Ralph W., Assistant Professor, co-author, "Microwave Sintering of Nanocrystalline Ceramics,"



in Symposium SXIV, Microwaves: Theory and Application in Materials Processing III, 97th Annual Meeting of the American Ceramics Society, Cincinnati, OH, April 30 - May 3, 1995.

KORZENIOWSKI, Kelly A., Assistant Professor, "3-D Dual-Drive Control for Object Recognition", 1994 American Control Conference, Baltimore, Maryland, June/July 1994.

Award Received at 1994 ACC for "Best Presentation in Section"

KORZENIOWSKI, Kelly A., Assistant Professor,

"Coordinating Robotic Sensors in a Complex Environment for Data Collection and Object Recognition", SPIE Sensor Fusion VII, Boston, Massachusetts, October 1994.

LIM, Tian S., Professor, "Undergraduate Engineering Laboratory in Counter Design," 1994 ASEE (American Society for Engineering Education) Annual Conference, June 25-30, 1994.

SELLAMI, L., S. Ahmadi, and R. W. Newcomb, "A CMOS PWL Fuzzy Membership Function," Proceedings of the IEEE International Symposium on Circuits and Systems, April-May 1995, pp 2321-2324.

# Mechanical Engineering

Professor Russell A. Smith  
Chair

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Research by faculty and midshipmen in the Mechanical Engineering Department reflects the broad interests of a diverse and highly qualified group of engineers. Project active in this period included internal combustion engines, fracture mechanics, fluid mechanics of bearings and pumps, thermal design, materials processing and engineering, corrosion, continuum mechanics, vibrations and flow field studies. In summary, the department was involved in 46 projects, of which 21 were sponsored research, 13 were midshipmen projects earning academic credit and 12 were independent projects. Research sponsors included the Office of Naval Research, Naval Surface Warfare Center, U.S. Nuclear Regulatory Commission, Naval Research Laboratory, Naval Civil Engineering

Laboratory, Applied Physics Laboratory, the U.S. Naval Academy Research Council. Numerous industrial sponsors provided substantial support to the hybrid electric vehicle project which completed its third year of competition.

Research efforts in the department are promoted by faculty and midshipman interest in studying new technology and solving problems of interest to the U.S. Navy. This activity not only creates excitement among the research teams, but promotes the study and introduction of new technology in the classroom. Faculty and midshipmen involvement in publication of research and invited presentations reflects credit and recognition for the individuals and the U.S. Naval Academy.

## Sponsored Research

### Structural Analysis

Researchers: Assistant Professor Oscar Barton, Jr.  
and Associate Professor Raouf A. Raouf

Sponsor: Naval Surface Warfare Center, Annapolis, Maryland

This research project is divided into three distinct parts:  
(1) Analyze the structural response of the Land Based Test Facility (LBTF); (2) Analyze contact stresses on

cylindrical pins. Derive mathematical expression to predict the contact stresses under various interference fits; (3) Construct fatigue curves for experimental data.

### Bending of Compression Behavior of Marine FRP Panels

Researchers: Professor T. W. Butler and G. J. White  
Sponsor: Johns Hopkins University, Applied Physics Laboratory

Using Naval Architecture, Ocean Marine Engineering's (NAOME) structural test frame, we have been arranging for the testing of 18 FRP panels which are

designed to be used as ship hull components. Testing consists of simultaneous in-plane compression and out-of-plane pressure (simulating hydraulic pressures).

### Development of an Automated Data Acquisition and Control System for an Ultra-filtration System

Researcher: Assistant Professor Gregory W. Davis  
Sponsors: Naval Surface Warfare Center-Carderock Division, Office of Naval Research

In an effort to meet more stringent environmental

regulations, the U.S. Navy is investigating several

methods to handle shipboard waste-water. Traditionally, this waste has been held in tanks for disposal either to pier-side waste handling units, or for disposal at sea. Two types of waste-water are generated on the ship: blackwater, and graywater. Blackwater is the term used to describe sewage, while the term graywater is used to describe non-sewage waste such as the waste from laundry and sinks. The U.S. Navy has responded to these concerns through the use of on-

board storage and off-board treatment of the blackwater. Unfortunately, this is not a viable means of operation for the handling of graywater due to the increased volume of effluent involved. Currently, the Navy is studying different methods for handling the graywater generated on-board its ships. The Carderock Division of Naval Surface Warfare Center, Annapolis, Maryland has been tasked to build and test this method for handling graywater.

### **The Effect of Synthetic Atmospheres on the Production of NOx in Diesel Engines**

Researcher: Assistant Professor Gregory W. Davis

Sponsors: Naval Surface Warfare Center-Carderock Division, Office of Naval Research

The effect that varying intake gas or atmospheric mixtures has on the nitrous oxide (NOx) production in diesel engines is studied. Exhaust gas recirculation (EGR) has been shown to decrease NOx emissions by up to 50% in most internal combustion engines. In the simplest terms, the use of EGR serves to dilute the percentage of oxygen present in the intake air. However, the chemical properties of the diluent also effect the formation of NOx. For example studies have shown that dilution with carbon dioxide is more

effective than dilution with nitrogen. The effect of the use of various diluents is to be better quantified in this project. After extensively upgrading the experimental facilities of the U.S. Naval Academy (USNA), an experimental investigation is to be conducted. Gas mixtures containing various concentrations of nitrogen, oxygen, carbon, dioxide and water vapor are to be used in the operation of a single cylinder co-operative fuel research (CFR) engine. The effect on the power emissions production will be measured.

### **Development of Hybrid Electric Vehicle Technology**

Researchers: Assistant Professor Gregory W. Davis and Major Frank Madeka, USAF

Sponsors: Chrysler, Ford, Kawasaki, General Electric, Baltimore Gas & Electric, Horizon Battery, Goodyear, United Emissions Catalyst, U.S.N.A. Alumni Association

A series Hybrid Electric Vehicle (HEV) has been developed for use in the Hybrid Electric Vehicle Challenges which took place during June of 1993 and 1994, and is scheduled to compete again in the 1995 Competition. These competitions are jointly sponsored by Ford Motor Company, Saturn Motors Corporation, Chrysler Corporation, the Society of Automotive Engineers, and the Department of Energy. The competition vehicle used is a result of a collaborative research and development effort by the midshipmen and faculty of the USNA. A 5-door Ford Escort Wagon with a manual transmission was converted to a series drive hybrid electric vehicle. The propulsion system is based on a DC motor which is coupled to the existing transmission. Lead-acid batteries are used to store the electrical energy. The auxiliary power unit (APU) consists of a small gasoline engine connected to a generator. The AMPhibian is designed to be an

economically feasible HEV, for use in near term applications. To accomplish this, all components are based upon existing technology. Further, this vehicle has been designed to retain, to the greatest degree possible, the basic driving characteristics of a conventional gasoline powered vehicle. The major performance design goals for the AMPhibian include 1) the ability to travel 64 Km as a zero emissions vehicle (ZEV) using battery power alone, 2) operating in hybrid mode, the ability to travel 320 Km while meeting the transitional low emissions vehicle (TLEV) air pollution standards, 3) achieve a time of under 15 seconds when accelerating from 0 to 70 Kph, and 4) climb a minimum of a 15% grade. The development and performance of this vehicle are experimentally measured and reported and compared with the original gasoline powered vehicle.

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## **Numerical Modeling of the Hydrodynamic Phenomena Around Bluff Bodies at the Free Surface**

Researcher: Assistant Professor Karen A. Flack

Sponsor: Naval Civil Engineering Laboratory, Port Hueneme, California

The hydrodynamic loads on moored ships are currently not accurately accounted for due to questions concerning the validity of model tests and limited full scale data. Recent improvements in numerical modeling, including improved turbulence models and memory requirements, have made numerical studies an attractive alternative as a tool to investigate this flow phenomena. Recent experimental results on bluff bodies including ship hulls (model and full scale) and cylinders indicate that the lateral force coefficient is dependent on

a number of parameters including depth of bluff body (depth to draft ratio), type of incident current (uniform, positive shear or negative shear), strength of sheared current, Reynolds number, and turbulence intensity. The scope of the current study is to investigate, through numerical modeling using the code PHOENICS, the flow around two-dimensional bluff bodies considering the vortex shedding, separation, and boundary layer interactions that may be responsible for the lateral force dependency on these parameters.

### **Hull/Fin Investigations**

Researcher: Professor J. D. Gillerlain, Jr.

Sponsor: Coastal Systems Station, Naval Surface Warfare Center  
Panama City, Florida

The accurate prediction of the hydrodynamic characteristics of submersible vehicles is an important part of the design process. Whereas extensive data are available for submarines and torpedoes, very little information exists for hull geometries similar to swimmer delivery vehicles (SDVs).

The objective of this phase of the study is to investigate the effectiveness of control fins at small

angles of attack on hydrodynamic vehicles operating in low Reynolds number regimes.

A literature search was conducted for available data for aerodynamic and hydrodynamic characteristics of wings and control fins on aircraft and submarines. Preliminary plans were made for windtunnel tests to study stall hysteresis and leading edge separation.

## **The Effect of Environment on the Mechanical Behavior of Composite Materials**

Researcher: Professor Dennis F. Hasson

Sponsor: Office of Naval Research

Future naval structural power systems require advanced engineered materials. Composites are candidate materials which could fulfill these requirements. For ships and aircraft structural applications the composite usually employs a polymer matrix composite (PMC), while for higher temperatures a glass or glass-ceramic matrix composite (CMC). These composite systems are designated PMC and CMC, respectively. While ambient condition mechanical property information is available, environmental effects on the performance of composites have not been extensively investigated. An example for CMC's is the effect of a soak in a high temperature oxidizing atmosphere on impact toughness; and for PMC's the effect of freeze/thaw cycles on the strength of a composite with a high water content.

Research activity for FY94 on CMC and PMC materials was as follows:

(a) Instrumented impact toughness tests were

performed on two CMC materials. These materials were FT 700 (Carbon) fibers in a barium magnesium aluminosilicate (BMAS) matrix and LOX M Tyranno (Si-C-Ti-O) fibers in a BMAS matrix. Half of the specimens of each material were ceramed to produce a glass-ceramic matrix. Fiber volume percents were 57 and 53, respectively. The architecture was unidirectional. The as fabricated FT 700/BMAS CMC had an impact toughness of 11.2J, while ceraming reduced the toughness to 8.5J. These values are higher than for carbon fibers in borosilicate glass (eg HMU/BSG). The impact toughness for the Tyranno fibers in the BMAS matrix was only 30 percent of the FT 700/BMAS values. The toughness was about the same for both as fabricated and ceramed. Planning of the test matrix for the study of the effect of a high temperature soak in air has been completed. Impact testing will be initiated when the conditioned samples

become available.

(b) A composite from a program to develop processing for the fabrication of fiber reinforced glass-ceramic composites from paper has been impact tested. The paper contained 0.5 inch long carbon coated Nicalon fibers and a lithium aluminosilicate (LAS) glass matrix. The fiber orientation in the paper was 2-D random. The impact toughness was 0.2J. The macroscopic fracture appearance was similar to that of a brittle material. Additional material with better mechanical properties and more uniform quality will be obtained.

(c) Fibrous monolithic ceramic material has been processed for impact testing. The material consists of high aspect ratio polycrystalline regions (cells) of a

primary phase separated by thin BN second phase regions (cell boundaries) designed to improve fracture resistance. The system under study has boron nitride cell boundaries in silicon nitride. The application of this material is for high temperature.

(d) The E glass/SP365 thermoset matrix PMC material panel was machined. The specimens are presently being soaked in room temperature water to obtain a high moisture content. Freeze/thaw cycling and subsequent mechanical testing are planned for Fall 1994. One presentation was given at the American Ceramic Society meeting in January 1995 at Cocoa Beach, Florida, and it was entitled "Commercial Development of Fibrous Monolithic Ceramics."

## Elastic Plastic Fracture Mechanics of LWR Alloys

Researcher: Professor James A. Joyce

Sponsor: United States Nuclear Regulatory Commission

This research project is conducting an investigation of the fracture behavior of metallic alloys used in LWR systems. The goal is to develop the fracture mechanics technology and methodologies necessary for predicting the behavior of LMR components containing flaws. The program involves testing fracture toughness

specimens of several geometries unloading surface cracks loaded in bending and in tension. Analysis includes 2D and 3D finite element work with crack extension and post processing the results in terms of proposed constraint parameters.

## 3-D Viscous Flow Analysis of a Shaftless Seawater Pump

Researcher: Associate Professor Steven M. Miner

Sponsor: Naval Surface Warfare Center, Annapolis, Maryland

The critical performance parameters in turbomachinery: efficiency, noise, vibration, and reliability, are all related to the flow field internal to the machine. In order to understand and predict these parameters, a detailed knowledge of the velocity and pressure fields within the rotating and stationary passages is required. If accurate predictions of the flow field can be made, then improvements in the performance parameters can be achieved in the early design stage of the machine, instead of later on in the design cycle. These improvements can mean reduced costs in the design of the machine, as well as, reduced costs associated with the operation and maintenance of the machine.

The objective of the current work is to evaluate the use of three-dimensional viscous flow analysis (Navier-Stokes equations) and the finite element method to predict the performance of a two stage axial flow pump. In particular, the velocity and pressure fields within the pump will be calculated and compared to experimental data available for the same geometry.

The project is broken into three stages:

1. Analysis of the first stage of the pump.

2. Comparison of the computational results to measured results for the first stage.

3. Analysis of the second stage of the pump.

The governing equations for the analysis of the axial flow pump are the continuity equation and the momentum equations in the R, Theta, and Z directions. These make up the Navier-Stokes equations, and are formulated in rotating coordinates for the analysis performed here. In addition, turbulence effects are also included by using the Reynolds averaged form of the equations and the k- $\epsilon$  turbulence model. These equations along with appropriate boundary conditions are solved for the three components of velocity and the pressure. A commercial code is being used to implement the solution of the governing equations.

Currently, a solid model of the first stage impeller has been generated, as well as, the model of a single blade passage within the impeller. Fluid flow solutions have been obtained. The results from these solutions have been compared to measured results at locations upstream and downstream of the impeller. The computational results capture both the shape and magnitude of the measured profiles for velocity, flow

angle, static pressure, and total pressure. Analysis of

the first stage is essentially complete.

## **Spray Forming Substrates**

Researchers: Assistant Professor Angela Moran,  
ENS Michael Makela and Engineering Technician John Hein  
Sponsor: Naval Surface Warfare Center, Annapolis, Maryland

Spray Forming is a new method for rapid deposition of metallic components for military applications. Currently spray formed components are limited to simple asymmetric shapes but the introduction of intelligent processing and computer controlled five axes robotics has extended the possible component configurations. A substrate material such as cement is

being investigated to use as an alternative to current substrate materials that must be physically removed from the spray formed part. Complex shapes such as tapered tubes, elbows and hemispheres are not amenable to extensive machining to remove substrates. This project is investigating alternatives to substrate materials and designs for easy removal.

## **Electrodeposition of Diamond Like Films**

Researchers: Professor Patrick J. Moran,  
LT Sandra Kwiatek, Dr. Paul Natishan, and Mr. John Hein  
Sponsor: Naval Research Laboratory

The objective of this program is to investigate the feasibility of producing diamond or diamond like films via electrodeposition. There has been unsupported claims in the literature that such films could be produced via electrodeposition on silicon substrates from ethanol electrolytes. We are attempting evaluating this approach and have, in fact, been able to electrodeposit carbon containing films. However, to

date, these films have not exhibited diamond or diamond like structure. We are varying processing variables such as electrodeposition voltage, temperature, and substrate material to fully evaluate the feasibility of this approach. Further, we are characterizing the structure and properties of all films obtained in this program.

## **Evaluation of Fatigue Corrosion Resistance of Fasteners for Marine Service**

Researchers: Professor Patrick J. Moran, Lieutenant Thomas Mohr, Mr. John Hein,  
Denise Taylor and Dr. RobTregoning, NSWC, Annapolis, Maryland  
Sponsor: Naval Surface Warfare Center, Annapolis Detachment

The objective of this program is to develop a rapid and reliable testing method to evaluate the corrosion fatigue susceptibility of materials used for marine fasteners. The approach involves the use of a relatively long fracture mechanics specimen which is tested in fatigue in a corrosive environment until the critical stress level is obtained and the crack no longer propagates (constant maximum displacement and decreasing maximum stress intensity). Then, the environment is made more corrosive by such methods as increasing cathodic protection level (to increase hydrogen entry)

and by introducing common seawater pollutants (which increase hydrogen entry). The displacement is increased slightly and the test is continued until a new critical stress level is obtained. This procedure can be repeated several times on one specimen as long as room for continued crack propagation remains. In this manner the influence of several levels of cathodic protection or the influence of several concentrations of seawater impurities can be determined in one test. The data obtained is being correlated with conventional corrosion fatigue testing methodology.

## **Development of a Remote Sensor for the Detection of Crevice Corrosion**

Researchers: Associate Professor Patrick J. Moran,  
Dr. Mahendra Sunkara (Faratech), Dr. Jennings Taylor (Faratech), and Mr. John Hein  
Sponsor: Office of Naval Research

Farachem Technology, Inc., located in Ohio has a Small Business Innovative Research Grant from Office of Naval Research to develop remote sensors for the detection of crevice corrosion in seawater piping systems. Professor Moran has expertise in crevice corrosion mechanisms and in magnetic detection of

corrosion currents. Through the Office of Naval Research Contract Professor Moran is assisting Farachem Technology, Inc. in the design and development of remote sensors for crevice corrosion based on detecting the small magnetic fields generated by the crevice corrosion currents.

## **Stability, Bifurcation, and Fracture in Continuum Mechanics**

Researchers: Associate Professor Raouf A. Raouf and Reza Malek-Madani  
Sponsor: Office of Naval Research

Under certain conditions, some materials develop regions of intense shear strains that are believed to cause failure. These regions are called shear bands.

The present research proposes a mathematical model to predict the onset of shear bands. The project is in progress.

## **Structural Analysis**

Researchers: Associate Professor Raouf A. Raouf and Assistant Professor Oscar Barton, Jr.  
Sponsor: Naval Surface Warfare Center, Annapolis, Maryland

This project is a continuation of earlier efforts in three major areas of interest for the Navy: structural integrity and load bearing capacity of fatigue test facilities that are being modified to accommodate large ship

propulsion shafts, stress distribution around solid inclusions in laminated composite plates and fatigue analysis of composites.

## **Dynamic Characterization of Novel Composite Materials when Incorporated into Engineering Structures**

Researcher: Assistant Professor Colin P. Ratcliffe  
Sponsors: Naval Surface Warfare Center, Annapolis, Maryland

This is an ongoing project investigating the use of a novel reinforced urethane matrix composite. The matrix has a very high internal damping, which makes it suitable for applications where noise attenuation is desirable. The primary aim of the overall project is to design a pressure hull component for an unmanned underwater vehicle. The researcher's involvement is to characterize the various designs, in order to identify the design with the desired vibration and noise properties. The main technique used is modal analysis, an experimental method of identifying the dynamic properties of an existing structure. This has been used

both in air, and underwater, with a great deal of success. The work devised a methodology whereby the simpler in air testing could be used to rank the underwater acoustic performance of different hull designs.

The new material is proving to be useful in many different areas, and as the project progresses, involvement has included theoretical and experimental analysis of several other engineering components, including armor plating, shaft couplings, bridge column reinforcement, fire and blast protection panels, and discussion on other projects.

## **Impedance Measurements of Pipe Strap Hangers**

Researcher: Assistant Professor Colin P. Ratcliffe  
Sponsors: Naval Surface Warfare Center, Annapolis, Maryland

Pipe strap hangers are widely used in surface ships and submarines. In addition to physically supporting the pipes, they also attenuate the vibration carried in the pipes. Accordingly, the hangers help to reduce the vibration energy transmitted to the hull, and thus attenuate the acoustic radiation potential from the hull into the surrounding sea water. This research characterized several different designs of pipe strap hangers, identifying their transmissibility and impedance. Solid rubber inserts are commonly used in

the hangers, but it was shown that these have an inferior performance when compared to a DIM pad insert. The characteristics as a function of bolt torque were also identified.

It was shown that the structural configuration of the hanger, at certain frequencies, caused unwanted resonances and standing waves. This unexpected phenomenon reduced the effectiveness of the hangers. As a result of this finding, the project may continue in the next fiscal year.

## **Prediction of the Transient Response of Nonlinear Resilient Engine Mounts in a Shock Environment**

Researcher: Assistant Professor Colin P. Ratcliffe  
Sponsors: Naval Surface Warfare Center, Annapolis, Maryland

One form of resilient mount used widely at sea consists of a metal flange, with a rubber component to act as the shock absorber. These mounts are very heavy, and when used in sea water, have a major corrosion problem. A major Department of Defense project was to redesign these mounts, replacing the metal flanges with a GRP composite flange. The rubber element in the original mount proved to function satisfactorily in service, and therefore the new design kept the same rubber component. As part of the acceptance trials the mounts have to pass a standard military specifications shock test. Traditionally, except for a pass/fail report, the shock test gives very little information about the performance of the mount itself. This project focused on the theoretical and experimental modeling of the

mount when subject to the shock test. The spring stiffness of both the existing and new designs is highly nonlinear, making the analysis significantly more complex than for a linear system.

When the theoretical predictions were compared to displacement data recorded on high speed video, there was excellent agreement. As a result, Naval Surface Warfare Center may sponsor a continuation project next fiscal year. This will be to extend the method for other shock tests and mount configurations, aiming to predict if a particular design will pass the test. Shock tests are expensive, and if this continuation project goes ahead, it may provide a powerful tool for the mount designer.

## **Use of Vibrational Analysis as an Aid to Damage Detection in a Ship Borne Mast Structure**

Researcher: Assistant Professor Colin P. Ratcliffe  
Sponsors: Naval Surface Warfare Center, Annapolis, Maryland

The NSWC is building a new design of ship borne mast structure. It will be approximately 70 feet tall, manufactured from composites using a sandwich-layer construction technique. Currently Naval Surface Warfare Center have a one-third scale model which has been subject to extensive testing. One concern with large-scale use of composites at sea is that there is little experience in identifying a structure that has partially failed. With more conventional materials, such as steel, corrosion and cracking are often noticeable, and

evidence of partial failure. This is not the case with GRP composites, where damage too small to see from a cursory examination may indicate the onset of catastrophic failure.

This is an ongoing project, using a new technique of vibration analysis as an aid to damage detection. The work is being conducted on part of the one-third scale model, and aims to identify both local and global damage. The project also includes an extensive literature survey. One important aspect of



the project is that the results should be applicable in-the-field. Therefore the work also includes a survey of vibration instrumentation, with a view to identifying

commercial portable or hand-held equipment suitable for at-sea use.

## **Design and Analysis of Pivoted-pad Journal Bearing**

Researcher: Professor Chih Wu

Sponsor: Naval Surface Warfare Center, Annapolis, Maryland

Pivoted-pad journal bearings have many attractive characteristics for naval shipboard application. These bearings have the ability to accommodate shaft deflection or misalignment and can therefore carry relatively high loads in cases where shaft deflection or misalignment is a factor. Another advantage is that clearance can be closely controlled by making the pivots adjustable radially, thus permitting operation with smaller clearance. These features make the bearings desirable for naval applications.

The objective of this project is to design and analyze a 30-tilting-pad journal bearing for a high

speed water lubricated pump. Basic theoretical analysis and simulation are important in the process of the design.

Fundamental lubrication equations and boundary conditions of the fluid flow field were set up. A computer software was used for the analysis with several parameters such as speed, clearance, eccentricity, journal radius, lubricant properties, etc. The effect of the parameters in the design of the bearing were found. A search of other approaches including finite-element and finite-difference methods has also studied.

## **Independent Research**

### **Sensitivity Analysis in Composite Structural Mechanics**

Researcher: Assistant Professor Oscar Barton, Jr.

Development of approximate expressions to predict the mechanical behavior, vibration and stability, of laminated composite structures using eigensensitivity analysis. In preparation for journal submittal are three manuscripts "Vibration of Non-Uniform Thickness

Orthotropic Plates using Eigensensitivity Analysis, "Buckling of Linearly Varying Thickness Orthotropic Plates using Eigensensitivity Analysis," and "Approximate Analysis of Shear Deformable Plates."

### **Development of Finite-time Thermodynamic Analysis**

Researcher: Assistant Professor Gregory W. Davis

Finite-time thermodynamic analysis can provide new insight into the theoretical of cyclic machine operation. Not only can it provide expressions for the upper bounds of efficiency and rate of desired energy delivered, but it can also provide additional insights into the design of these devices. The information provided using this technique is more conservative than provided in the Carnot cycle analysis, and, therefore, is

more useful to the design engineer. The method of investigation is purely theoretical due to the nature of the analysis. To date, several cyclic devices have been analyzed, including geothermally powered heat pumps and air conditioners, regenerative Stirling cycles, etc. Research is currently in progress involving the utilization of low-grade thermal energy, and cascade Rankine power cycles.

## **Three-Dimensional Turbulent Boundary Layer Near-Wall Structure**

Researcher: Assistant Professor Karen A. Flack

Turbulent boundary layer flow was once thought to be a chaotic mess of structures, basically a "spaghetti bowl" of vortex filaments. However, flow visualization has shown that a turbulent boundary layer actually contains a regular pattern of coherent structures. The coherent structures of two-dimensional boundary layers have been studied intensively over the past thirty years using flow visualization and statistical measurement techniques. A better understanding of these structures has led to research concerning the control of the turbulent boundary layer in an effort to minimize surface drag. The current research focuses on the coherent structures in the near wall-region of a three-dimensional turbulent boundary layer flow, to

determine the influence of cross-flow on the near-wall turbulence structure. The research consists of a careful study of flow visualization from two distinct three-dimensional turbulent boundary layer experiments. The flow visualization was previously performed (Flack & Johnston 1993) and saved on video tape for subsequent analysis. A computer system was used for the frame-by-frame analysis of the coherent structure development. Results of this investigation indicate that three-dimensionality stabilizes ejection events creating a more quiescent near-wall flow, however the cross-flow does not influence the sign or strength of the near-wall vortical structure.

## **Three-Dimensional Turbulent Boundary Layer Near-Wall Similarity**

Researcher: Assistant Professor Karen A. Flack

Predictive codes for the computation of turbulent flows in complex engineering devices require substantial computing resources and time. However, if the code is to be more than a basic research tool, and to be useful to the community of engineering designers, then it must run rapidly and at a relatively low cost. For three-dimensional boundary layer problems the effort (mesh size, memory, etc.) increases, necessitating more powerful and expensive computers. The mesh size near the wall, where severe velocity and pressure gradients occur becomes extremely small. Equations that model the near-wall flow would greatly reduce computational time and cost. The current research focuses on the

determination of wall functions for three-dimensional turbulent boundary layers, with the ultimate goal of possibly extending near-wall similarity relationships of two-dimensional boundary layers to three-dimensional flows. So far, the research has established a near-wall empirical equation that models a stress/strain parameter using experimental data. Currently the research is of a more analytical nature, focusing on mean-flow parameters (mean velocities, flow angles, pressure gradients) in the near-wall region for strongly three-dimensional flows. Analytical functions for mean flow parameters have been tested against experimental data.

## **Water on Mars**

Researcher: Professor Robert A. Granger

When one uses the title WATER ON MARS as the subject of a research paper, the reader conjures up many topics that are as varied as can be conceivably imagined. The subject is enormously complicated and issues such as water sources and sinks, and mechanisms which carved the great channels on Mars, will never be satisfactorily addressed until man lands on Mars.

The literature on the subject is vast. This research addresses the following topics: the possible existence of standing bodies of liquid water very early in martian history and the present distribution of martian ground

ice; the hydrological cycle on Mars; the precise mineralogy of the abundant martian dust; the dust/ice ratio of the polar layered deposits; the porosity of the brecciated material and its thickness; the rheological behavior of ice on Mars; the effect of climate on the water distribution; the mechanism of martian thermokarst; and the precise history of groundwater sapping channels. Some of these issues have already been solved in the research. Work is continuing slowly as this research is unfunded; yet, my interest still remains.

## Fluid Dynamics of Cosmology

Researcher: Professor Robert A. Granger

The fluid dynamics of cosmology is an on-going research task that is directly related to an interest in quantum cosmology. It involves the General Theory of Relativity. relativistic fluid dynamics involves five dependent functions that describe the state of the fluid. Three of them are kinematic variables and two are thermodynamic. The independent variables are four: an event and a four-dimensional continuum denoted as space time, which has an indefinite metric. The inertial coordinate systems are the ten-parameter Poincare group where the five conservation laws are invariant. General relativistic fluid mechanics differs from special relativity since the independent variables of the

conservation equations refer to a curved space-time. The kinematics involving comoving coordinates are well known. The transport of vector fields along these curves are also well known such that wave velocity and symmetries are well posed.

In relativistic theories, fluid behavior is described by the four velocity vector field and by the stress-energy tensor of the fluid. One can then derive the equations describing the motion of any relativistic fluid by the five conservation laws and apply the results to a perfect fluid. Work is progressing on examples of special relativistic flows such as isentropic one-dimensional flow.

## Coherent Structure of Turbulence

Researcher: Professor Robert A. Granger

The research into coherent structure of turbulence deals with the morphology of the vortical nature of shear flows usually defined in turbulent boundary layer flows. In the boundary layer, there are three kinds of vortices: i) the near wall eddies, the buffer zone eddies or Falco eddies, and the other eddies. For the latter, we are concerned with eddy production, entrainment, and mixing. These eddies are large, random in both space and time and are often associated with Emmons spots, for small to moderate Reynolds number. The Falco eddies are also three-dimensional and highly coherent,

appearing in wakes and jets, grid-generated turbulence, and flow past bodies with both adverse as well as favorable pressure gradients. Falco eddies are important in linking the eddies of the near wall with the eddies of the outer region. For the near wall, half the production of the turbulent kinetic energy takes place. It is in this region that the bursting phenomenon takes place. Research is continuing in all three regions trying to unify the velocity fields for a wide range of pressure gradients.

## Effect of Evaporator Design Pressure on Absorption Heat Pump Performance

Researchers: Assistant Professor Sheila C. Palmer, Associate Professor Samuel V. Shelton (Georgia Institute of Technology), and David N. Ivester (Atlanta Gas Light, Atlanta, Georgia)

The effect of evaporator pressure on absorption heat pump performance is explored for three ammonia-water absorption cycles, two single-effect and one triple-effect. The evaporator pressure is the low-side pressure of the system. The pressure can be varied from that which provides no concentration swing in the solution loop to that which provides no temperature glide across the evaporator. The coefficient of performance (COP) is found to be a function of

evaporator pressure. The evaporator pressure which provides the maximum COP is determined for the three cycles. The evaporator pressure which produces the highest COP is the "optimum" evaporator pressure. At the optimum evaporator pressure for the single-effect cycles, the temperature difference at each end of the precoolers is the same and both temperature differences are equal to the minimum system heat exchanger pinch point.

## **Pinch Point Design of the GAX Heat Exchanger for Ammonia/Water**

Researchers: Assistant Professor Sheila C. Palmer  
and Associate Professor Samuel V. Shelton (Georgia Institute of Technology)

In the single-effect generator-absorber heat exchange (GAX) absorption cycle, the direct-contact heat exchanger between the generator and absorber is the GAX heat exchanger. The design of this heat exchanger is pivotal in the development of the GAX cycle for residential and light-commercial applications. Typically, the minimum temperature difference (i.e.,

the pinch point) for the GAX heat exchanger is thought to occur at the absorber end of the heat exchanger. This study shows that the pinch point may occur at the generator end of the GAX heat exchanger when the concentration of the weak (with respect to refrigerant) solution in the solution loop approaches zero.

## **Sensitivity Analysis of Absorption Fluid Thermodynamic Properties**

Researchers: Assistant Professor Sheila C. Palmer  
and Associate Professor Samuel V. Shelton (Georgia Institute of Technology)

The performance limitations of single-effect absorption heat pumps can be overcome by using more effective heat exchangers and/or finding new working fluid pairs. This study focuses on determining the desirable properties for a new working fluid pair. The binary solution is modeled using an ideal solution model and the Peng-Robinson (PR) equation of state (EOS). Both

solution models show that COP increases as the volatility of the refrigerant increases and as the volatility of the absorbent decreases. However, the improvement in COP does not increase without limit as volatility of the refrigerant increases. There is a point beyond which increase in refrigerant volatility causes a decrease in COP.

## **Nonlinear Dynamics of Composite Shells with Double Curvature**

Researcher: Associate Professor Raouf A. Raouf

This research effort focuses on the effects of the geometric and material properties such as, fiber orientation and on the nonlinear characteristics of composite shells with double curvature, such as

toroidal shells. The research studies the nonlinear frequency characteristics and the instability of these structures are of interest to the Navy.

## **Structural Imaging as a Method of Non-Destructive Examination**

Researcher: Assistant Professor Colin P. Ratcliffe

This ongoing project is investigating the use of experimental modal analysis as means of structural non-destructive examination (NDE). Modal analysis is a method of determining the dynamic characteristics of a structure in principle (or modal) coordinates. The response in each principle coordinate is affected by the response in every spatial coordinate, and therefore work by other researchers has concentrated on transforming the measured modal constants into spatially equivalent mass and stiffness matrices. This

research is investigating the use of principal coordinate information directly as a means of identifying the location of damage.

The work is a spin-off from a funded research project. In the EM423 Mechanical Vibrations elective course midshipmen conduct a short project. Several of these projects have investigated modal analysis for NDE, and some of their work will be collected together, and used as a source for technical papers and other research.

# Research Course Projects

## Vibration Analysis of Composite Plates

Researcher: Midshipman 2/C Joshua Price, USN

Adviser: Assistant Professor Oscar Barton, Jr.

In this project eigensensitivity analysis will be used to investigate approximate closed-form expressions for the free vibration of symmetric angle-ply laminates. Various combinations of simply supported, clamped and free support boundary conditions will be

considered. Orthogonal polynomials will be used to generate a kinematically admissible, complete basis. Numerical results from each expression will be compared to the well known Rayleigh-Ritz technique and to other published literature.

## Buckling of Composite Plates

Researcher: Midshipman 2/C Sean P. Boles, USN

Adviser: Assistant Professor Oscar Barton, Jr.

Techniques used to analyze mechanical behavior of symmetric composite laminates has dominated by numerical techniques. An alternative approach is the development of approximate closed form solution using sensitivity analysis.

Sensitivity analysis has been successfully implemented to develop approximate closed form expression for the buckling of rectangular symmetric

angle-ply laminates for various combinations of clamped and simply supported plates. These expressions cannot be used directly for repeated buckling loads.

This project seeks to develop a subroutine that removes the singularity corresponding to repeated buckling loads using a similarity transformation.

## Failure of Aluminum Bolted Connections

Researcher: Midshipman 1/C J. Froehner

Adviser: Professor T. W. Butler

Mr. Froehner had a series of steel plates machined and drilled to accommodate various arrangements of bolts. He then loaded the plates, which were fastened together

with aluminum bolts, to failure. Five different configurations were used with the failure loads all within about 3% of the predicted failure loads.

## Adaptation of a Spark-Ignited Engine for use on a Water Brake Dynamometer

Researcher: Midshipman 1/c Jeffrey L. Boaz, USN

Adviser: Assistant Professor Gregory W. Davis

A Ford Modular V-8 engine was mechanically adapted for experimental use on an existing water-brake engine dynamometer. This adaptation included the design and construction of engine mounting brackets and a means

of coupling the engine to the dynamometer. Additionally, the engine wiring harness was adjusted for this application.

## **Modification of a Spark-Ignited Engine Control System Allowing Engine Operation without a Chassis**

Researcher: Midshipman 1/c Jeffrey L. Boaz, USN

Adviser: Assistant Professor Gregory W. Davis

The electronic engine control system (EECS) for a Ford Modular V-8 engine which had been previously adapted for experimental use on an existing water-brake engine dynamometer was studied and adapted to allow operation of the engine beyond that intended in chassis use. This adaptation included determining signals expected by the EECS. Once this level of expertise was attained, all expected signals were

synthesized and used to mimic the operation of real vehicle in order to meet the operating conditions expected by the EECS system. This process was complicated by the lack of published information available on this proprietary control system. At the completion of the project, the engine could be operated on the engine dynamometer.

## **The Neutralization of Surf Region Mines**

Researcher: Midshipman 1/C So Won Silas Ahn

Adviser: Professor Robert A. Granger

This research is an extension of Granger's work in the hydrodynamics of a towed line array. The configuration is a scaled model of a net array being towed at the matching Reynolds number for the prototype being rocketed through air. Complete similitude was therefore maintained. Lift and drag were measured for a range of angles-of-attack, Reynolds number, spacing of charges and number of arrays in the net. An enormous amount of data was obtained and processed. The results were compared against the line array results of Granger, which had previously been confirmed both analytically and in the

field for accuracy. The lift and drag was normalized with respect to the dynamic pressure for ease in application by the contractor to field tests. The results were then processed in a regression analysis for ease in handling. Curves of form showed many surprising results, indicating that for certain conditions, instabilities could arise that make the use of a net array impractical for deployment. A new design, anagrammatized as the BLURB, would achieve the same results as a net, yet would not experience any of the instabilities noted in the net configuration. It would also be cheaper to manufacture and deploy.

## **Testar Controller Programming**

Researchers: Ensign Bill Mallory, USN

and Ensign Greg Mierwicki, USN

Adviser: Professor James A. Joyce

The objective was to convert existing BASIC programs for fatigue crack growth and precracking of fracture toughness specimens to the MTS Testar System. This involves programming in C and utilizing the features of

the OS/2 2.1 Presentation Manager. This work is presently in the early stages of development but shows great promise to greatly enhance the present testing capabilities.

## **The Effect of Exposed Time at Sensitizing Temperature on the Sensitization of 302 Stainless Steel**

Researcher: Midshipman 1/C Scott Drayton, USN

Advisers: CDR H. L. Lee and Professor P. J. Moran

After the stainless steel is heated in the temperature range of 500-900 °C, it shows susceptibility to the intergranular corrosion along the grain boundaries.

This temperature range is called sensitization temperature. In this experiment, three groups of austenite stainless steel 302 samples were heated to 600

C and maintained for 2 minutes, 13 minutes, and 25 minutes respectively. Double loop electrochemical potentiodynamic reactivation (EPR) technique was used to determine the effect of heating time at the sensitization temperature on the corrosion susceptibility

of stainless steel 302. The data showed that as the holding time of a sample at the sensitization temperature increases the degree of sensitization also increases.

### **The Effect of Exposed Area on the Sensitization of 302 Stainless Steel**

Researcher: Midshipman I/C Eric Hayes, USN  
Adviser: CDR H. L. Lee and Professor P. J. Moran

Heating stainless steel to a temperature of between 500 and 900 C causes chromium carbides precipitation and leaves chromium depleted regions near the grain boundaries. This results in a region which is sensitive to corrosion. The degree of sensitivity or sensitization is a measure of the susceptibility of stainless steel to experience intergranular corrosion. One is interested in determining whether or not the amount of exposed surface area of a specimen effects the degree of

sensitization. The double loop EPR test was used to measure the degree of sensitization in a specimen of stainless steel and determine if area has an effect. The test produced reactivation current density data and anodic current density data which were used to determine a ratio of ( $i_r/i_a$ ) as a measure of the sensitization. The data proved that the surface area has no effect on the degree of sensitization of 302 austenite stainless steel.

### **The Effect of Heat Treatment on the Sensitization of 302 Stainless Steel**

Researcher Midshipman I/C John Hopper, USN  
Advisers: Commander H. L. Lee, USN and Professor P. J. Moran

Heating stainless steels to moderate temperatures causes sensitization. At these sensitizing temperatures the chromium molecules are brought out of solution and make chromium carbide at the grain boundaries, leaving adjacent areas chromium depleted and highly susceptible to corrosion. In this experiment, the effect of heat treatment at this sensitizing temperature on the intergranular corrosion of stainless steel was studied. For this purpose, stainless steel 302 samples were

heated to 750 C and held for various lengths of time. After being quenched in water, a double loop EPR technique was used to analyze the amount of sensitization which is present in the sample. The results showed that as the samples are held for increasing lengths of time at the sensitizing temperatures, the amount of sensitization also increases. However, the increase of sensitization was not exactly proportional to the exposed time.

### **The Effect of Heat Treatment on the Sensitization of Duplex Stainless Steel**

Researcher: Midshipman I/C Scott Drayton  
Advisers: Commander H. L. Lee, USN and Professor P. J. Moran

Duplex stainless steel has higher corrosion resistance and better mechanical properties than conventional type 300 series stainless steel. The aim of the present work was to study the effects of heat treatment on the sensitization of duplex stainless steel to the intergranular corrosion. For this purpose, the

relationships between the microstructures, double loop EPR Test results, and Rockwell C hardness test values were studied. The results enabled relationships to be drawn between heat treatment, microstructure, electrochemical properties, and hardness values.

## **The Effect of Cooling Rate on the Sensitization of Duplex Stainless Steel**

Researcher: Midshipman 1/C Eric Hayes  
Advisers: CDR H. L. Lee and Professor P. J. Moran

Microstructure of duplex stainless steel is dependent on the cooling rate from the two-phase region which determines the corrosion characteristics of duplex stainless steel. To determine the effect of cooling rate on the sensitization of duplex stainless steel, the duplex stainless steel samples were heated to 1150 C and held for 15 minutes followed by cooling to room

temperature at different cooling rate. Then, the relationships between the microstructures, double loop EPR test results, and rockwell hardness test values were studied between the samples experienced different rate of cooling. The results enabled relationships to be drawn between heat treatment, microstructure, electrochemical properties, and hardness values.

## **Modal Analysis of Tires**

Researcher: Midshipman 1/C P. Croci  
Adviser: Associate Professor Raouf A. Raouf

The goal of this project is to determine the dynamic characteristics (natural frequency and mode shapes) of a tire using techniques from Computer Aided

Engineering and the I-DEAS software. The study was conducted using the finite element method.

## **Publications**

BARTON, Oscar, Assistant Professor, and Robert Reiss, co-author, "Approximate Fundamental Frequency of Variable Thickness Composite Plates," International Conference on Computational Engineering Sciences, July 30, 1995 - August 3, 1995, Mauna Lai, Big Island Hawaii, USA, Computational Mechanics Theory and Applications, Volume 2, 2269-2274.

An approximate closed-form expression is sought which can be used to compute the fundamental frequency of composite rectangular laminates of variable thickness. After casting the governing differential equation into discrete form using the Ritz method, the desired closed-form expression for the fundamental frequency is developed by expanding the discrete equations in a Maclaurin series about the off-diagonal elements of both the stiffness and mass matrices. Since the resulting expression is dependent upon the chosen admissible basis, results for both beam shape functions and orthogonal polynomials are computed for clamped boundary conditions. Comparison of the predicted fundamental frequencies with those numerically obtained for a variety of plate aspect ratios and taper ratios demonstrates the utility of the derived expression.

DAVIS, Gregory W., Assistant Professor, "Optimal Performance of a Geothermal-Heat-Engine-Driven-Heat-Pump System", The International Journal of Energy, Volume 19, No. 12, p. 1219, 1994.

A geothermal heat-powered, low-temperature Rankine cycle is suitable for the operation of a conventional mechanical compression heat-pump cycle in providing heating and cooling loads. This system is analyzed using a finite-time thermodynamic approach. The only irreversibilities are associated with heat transfer between the system and surrounding thermal reservoirs.

DAVIS, Gregory W., Assistant Professor, "The Effect of a Regenerative Braking System in the AMPhibian Hybrid Electric Vehicle", Proceedings of the 29th Intersociety Energy Conversion Engineering Conference, Volume 3, pp. 1430-1435, AIAA-94-4225-CP., 1994.

A series Hybrid Electric Vehicle (HEV) has been developed for use in the intercollegiate 1993 and 1994 Hybrid Electric Vehicle Challenges. A conventionally powered vehicle was converted to a series drive hybrid electric vehicle. The AMPhibian is designed to be an economically feasible HEV, for use in near term applications. To accomplish this, all components are



based upon existing technology. Regenerative braking is used to improve the performance of the hybrid electric vehicle. The design and performance of the vehicle are reported.

DAVIS, Gregory W., Assistant Professor, and Wu, C., "Optimal Performance of a Heat Engine-Driven-Heat Pump System Utilizing Low Grade Thermal Energy", AES Volume 33, ASME, pp. 271-275, 1994.

A low-temperature Rankine cycle utilizing low grade thermal energy is used to drive a conventional mechanical compression heat-pump cycle, providing heating and cooling loads. Typically, the performance of such a system would be modeled using Carnot cycle heat engine driving a Carnot cycle heat pump. The efficiencies of real cyclic devices do not approach those of Carnot devices due to the many irreversibilities associated with each of the processes. To achieve acceptable rates of energy transfer, the heat transfer processes must occur through finite temperature differences and in finite time, making these processes irreversible. This system is analyzed using a finite-time thermodynamic approach where the only irreversibilities are associated with heat transfer between the system and surrounding thermal reservoirs. This approach provides more realistic upper bounds for the performance of such a device and information regarding optimum working fluid temperatures.

DAVIS, Gregory W., Assistant Professor, and Madeka, F. C., "The Effect of Regenerative Braking on the Performance and Range of the AMPhibian II Hybrid Electric Vehicle", SAE 950957, and re-printed in SAE Special Publication SP-1089, 1995.

A HEV has been developed for use in the intercollegiate 1993 and 1994 Hybrid Electric Vehicle Challenges. A conventionally powered vehicle was converted to a series drive hybrid electric vehicle, named AMPhibian II. The AMPhibian is designed to be an economically feasible HEV, for use in near term applications. To accomplish this, all components are based upon existing technology. Regenerative braking is used to improve the range and economy of the hybrid electric vehicle. The design and performance of the vehicle, including the relative benefits of regenerative braking are reported.

DAVIS, Gregory W., Assistant Professor, co-author, "AMPhibian Evolution: The 1994 United States Naval Academy Hybrid Electric Vehicles", SAE Special Publication SP-1103, 1995.

The development of the 1994 USNA Hybrid Electric Vehicle, called AMPhibian II is presented including

design decisions and performance results of the vehicle. AMPhibian II is a conventionally powered vehicle which was converted to a series drive hybrid electric vehicle. The AMPhibian II is designed to be an economically feasible HEV, for use in near term applications. To accomplish this, all components are based upon existing technology. Regenerative braking is used to improve the range and economy of the hybrid electric vehicle.

GRANGER, Robert A., Professor, Fluid Mechanics, New York: Dover Publications, Inc., 1995.

This text designed to provide an orderly structured introduction to fluid mechanics, a field all too often seen by students as an amorphous mass of disparate equations instead of the coherent body of theory and application it should be. In addition, the book will help upgrade students' mathematical skills as they learn the fundamentals of fluid mechanics.

The text presents a unified method of analysis that poses fluid mechanics problems in precise mathematical language without becoming stiff or unnecessarily rigorous. This method involves three steps: First, the text carefully defines each problem so the student knows what is given and what is missing. Second, each chapter treats the physical aspects of the problem so the student can visualize how things work in the real world. Third, the text represents the physical model by appropriate mathematical symbols and operators, collects these into equations, and then solves them. The result is a superb learning and teaching process that covers everything the engineer needs to know - nature of fluids, hydrostatics, differential and integral equations, dimensional analysis, viscous flows and other topics, while allowing students to see each element in its relation to the whole.

Each chapter contains numerous examples incorporating problem-solving techniques, demonstrations to illustrate topical material, study questions, boxed equations of significant results, appropriate references to supplementary materials and other study aids. Over 760 illustrations enhance the text. This volume will be an indispensable reference and resource for any student of fluid mechanics or practicing engineer.

GRANGER, Robert A., Professor, "Differential Forms Versus Tensors," USNA Report EW-02-95, February 1995.

Differential forms enable mathematicians to make certain types of calculations faster than use of conventional tensor calculus. Boothby, Reference 1, is an excellent source on differential manifolds and Riemannian geometry. We shall present some ideas

and relationships applicable to the subject of general relativity.

The algebra of differential forms is first reviewed. The connection 1-form, the exterior differential and the Ricci rotation coefficients are presented. Next, the Riemann-Christoffel tensor is expressed in terms of differential forms. The results are the famous Cartan's first and second equation of structure. An example of Riemann-Christoffel tensor is given.

GRANGER, Robert A., Professor, "On Similarity Transforms," USNA Report EW-01-95, January 1995.

Similarity transformations are widely used in all branches of physics, especially fluid dynamics. Texts, such as Rogers, that devote significant pages to the topic and applications, as well as countless Ph.D. theses, such as my own.

Consider a parabolic differential equation, the heat conduction equation. Similarity transformations are used to transform the number of independent variables to a single independent variable, the similarity variable, by expressing the dependent variable, the similarity transform, in terms of this single variable. The equation is expressed in dimensionless form to avoid any fixed length scale. For heat conduction, there exists a typical time scale for which time will decay.

GRANGER, Robert A., Professor, "On a Particular Fourier Inversion," USNA EW-19-94, December 1994.

It is well known that  $f(x)$  is the Fourier transform of  $g(x)$  if a specific integral expression exists. Under suitable conditions on  $g(x)$ , it can be shown that similar expression exists for  $g(x)$  if  $g(x)$  is of bounded variation in the neighborhood of  $x$ . Inversion formulae are solutions of well known integral expressions, where conditions must be imposed on  $f(t)$  of the integral of  $g(x)$  and on the path of integration of the contour integrals.

In formulating a solution to a particular aerodynamic unsteady stability problem, it became necessary to evaluate a specific Fourier inversion expression that is similar to that in the math literature. Using the well-known relationships of Bateman, a unique inversion relationship was derived that is new to the literature.

GRANGER, Robert A., Professor, "The Theoretical Treatment of Two-Dimensional Vortex Interactions," USNA EW-18-94, November 1994.

In the observation of the behavior of individual vortices evolving through a series of equilibrium states until the states become unstable, a general theory for two-

dimensional vortex interaction can be developed. Once the equilibrium state is reached a relatively fast unsteady evolution begins that involves other closely placed vortices. During this fast unsteady evolution, a fraction of the original coherent circulation is lost to debris filaments and remarkably, the flow reorganizes into a set of quasi-steady stable vortices.

The simplifying nature of the theory is its use of adiabatic steadiness and marginal stability to determine the shapes and separation distance of vortices on the brink of convective evolution. As a result, the distance for the inelastic interaction of nearby vortices is reduced considerably. In the case of two vortices, inelastic interactions depend on only a single parameter: i.e., the ratio of areas of the two vortices, providing their vorticities are equal. Without imposing adiabatic steadiness, one would have to consider vortex separation and shape, which would greatly complicate the solution.

GRANGER, Robert A., Professor, "Confined Swirling Flow Stability," USNA EW-17-94, November 1994.

The linear stability of a rotating flow in a disk-cylinder system is well known, governed by Taylor numbers. The Navier-Stokes equations are linearized in the vicinity of a stationary solution. The eigenmodes can be calculated for different Reynolds numbers ( $Re$ ) and aspect ratio. The critical Reynolds number is determined as the value at which the real part of the dominant eigenvalue is zero. The corresponding eigenvector describes the most unstable perturbations of the flow. We know that vortex breakdown occurs at  $Re$  values below critical  $Re$ , indicating that vortex breakdown is not an effect of instability. The critical eigenmodel exhibits the same pattern for flows with  $H/R = 2.5$ , or without ( $H/R = 1.5$ ) a vortex breakdown. Hence, the instability is caused by the base flow and not by the vortex breakdown. At  $H/R = 2.5$ , the value of the critical  $Re = 2700$  is in good agreement with Granger (1).

The unsteady vortex breakdown computed by Lopez by a full time-marching solver of the full Navier-Stokes equations exhibited instantaneous streamline patterns which vary periodically between two merged and separated vortex bubbles. The same patterns were published recently.

GRANGER, Robert A., Professor, "Towing Basin Tests of a Line Charge: Final Report," USNA Report EW-04-94, September 1994.

The present experiment is an extension of the study performed under Contract No. N6133193WR32030. The testing was performed in the U. S. Naval Academy (USNA) Hydrolab's 380-ft towing tank using both

cylindrical and octagonal charge test specimens provided by NSWC Indian Head Division.

For each design test, 5 parameters were of interest: towing velocity, angle-of attack, axial roll angle, number of charges, and pretension. the spacing between charges was fixed at 3 feet. Various configurations of the charge system, consisting of variations of the aforementioned parameters, were tested in the two tank where hydrodynamic forces of lift and drag were recorded. Flow visualization using vegetable dyes mixed with milk injected through a capillary system mounted in a test cylinder upstream of the models was performed to illustrate the vortex-turbulent behavior of representative test specimens. All of the test runs were recorded on video tape and form part of this report.

HASSON, Dennis F., Professor, co-author, "Commercial Development of Fibrous Monolithic Ceramics," Ceramic Engineering and Space Proceedings, Volume 16, No. 4, 673-682, January 1995.

The fibrous monolith, a novel macrostructural architecture is demonstration high toughness and flaw tolerance in a battery of mechanical tests, including flexural and Charpy V-notch. Fiber architectures strongly influence the composite properties, implying that the materials system can be engineered for specific applications. With the flexibility inherent in the fabrication process, this is a reality.

Engineered applications are already being designed and tested. Thermal shock tolerant materials have been fielded. As the properties database builds, fibrous monoliths are expected to fit into mainstream engineering ceramics applications.

JOYCE, James A., Professor, co-author, "Effects of Cyclic Loading on the Deformation and Elastic-Plastic Fracture Behavior of a Cast Stainless Steel," Third International Symposium on Elastic-Plastic Fracture Mechanics, ASTM STP 120T, Philadelphia, 722-741, December 1994.

The objective of this program was to develop the appropriate material properties to characterize the cyclic tensile deformation, cyclic elastic-plastic crack growth, and the ductile tearing resistance of a pipe elbow made from a cast stainless steel equivalent to ASME SA-351CF8M. This material was used for large scale tests in the High Level Vibration Test program which applied intense cyclic loadings to reactor piping system components and revealed that fatigue crack growth could be a serious problem in these components.

The tests conducted included monotonic and

cyclic tensile tests, monotonic J-R curve tests, and cyclic elastic and elastic-plastic fatigue crack growth rate tests. The cyclic elastic-plastic fracture behavior of the stainless steel was of primary concern and was evaluated using a cyclic J-integral approach.

It was found that the cast stainless steel was very resistant to ductile crack extension. J-resistance curves essentially followed a blunting behavior to very high J levels. High cyclic fatigue crack growth rate data obtained on this stainless steel was typical of that reported in standard textbooks. Low cycle fatigue crack growth rate data obtained on this material using the cyclic J integral approach was consistent with this high cycle fatigue crack growth rate and with a standard textbook correlation equation typical for this type of material. Evaluation of crack closure effects was essential to accurately determine the crack driving force for cyclic elastic-plastic crack growth in this material.

JOYCE, James A., Professor, co-author, "Application of Fracture Scaling Models to the Ductile to Brittle Transition," USNRC, NUREG/CR-6279, January 1995.

And

JOYCE, James A., Professor, co-author, Link, R. E., "Experimental Investigation of Fracture Toughness Scaling Models, " Constraint Effects in Fracture: Theory and Applications, ASTM STP 1244, Mark Kirk and Ad Bakker Eds., American Society for Testing and Materials, Philadelphia, 1994.

An experimental investigation of fracture toughness in the ductile-brittle transition range was conducted. A large number of ASTM A533, Grade B steel, bend and tension specimens with varying crack lengths were tested throughout the transition region. Cleavage fracture toughness scaling models were utilized to correct the data for the loss of constraint in short crack specimens and tension geometries. The toughness scaling models were effective in reducing the scatter in the data, but tended to over correct the results for the short crack bend specimens. A proposed ASTM Test Practice for Fracture Toughness in the Transition Range, which employs a master curve concept, was applied to the results. The proposed master curve over predicted the fracture toughness in the mid-transition and a modified master curve was developed that more accurately modeled the transition behavior of the material. Finally, the modified master curve and the fracture toughness scaling models were combined to predict the as-measured fracture toughness of the short crack bend and the tension specimens. It was shown that when the scaling models over correct the data for loss of constraint, they can also lead to non-

conservative estimates of the increase in toughness for low constraint geometries.

LOPARDO, V. J., Professor, with C. Wu, "Engineering Education: Future Directions," Proceedings of American Society for Engineering Education, June 1994.

The future of engineering education as viewed by the authors is presented. A general brief review of engineering education in the United States and other countries is given and a proposal made that engineering educators and universities must take a leadership role in the packaging of new, innovative programs. The importance of the role of students, faculty, curricula, and universities is discussed. A case is made for more design and manufacturing as well as the need for more hands on laboratory experience. A strong plea is also made to support "continuing education" for all engineers.

MORAN, Angela L., Assistant Professor, co-author, "Intelligent Spray Forming," Proceedings of the 41st Sagamore Conference, August 1994, in press.

The spray forming process is ideally suited to the application of intelligent control methods. The process has significant metallurgical and economic benefits, but requires sophisticated control technology to achieve the level of reliability and reproducibility required for widespread commercialization. Process models are a precursor for such control and are under development. Critical process parameters can be sensed and controlled via a fuzzy logic controller that identifies and implements parametric actions based on process conditions. This paper highlights intelligent spray forming studies at Drexel University and the Naval Surface Warfare Center.

MORAN, Angela L., Assistant Professor, co-author, "Foreign Comparative Test Program for Spray Formed Alloy 625 Piping," NSWC Report CARDIVNSWC-TR-61 94/45, December 1994.

As part of a Foreign Comparative Test Program, mechanical and metallurgical properties of spray-formed Alloy 625 piping were evaluated and compared to conventionally-processed, seamless Class 850 Alloy 625 pipe. Comparisons of two finishing processes namely, roll-extrusion and pilger-rolling, were made based on microstructure, non-destructive evaluation, strength, ductility, hardness, impact toughness, fatigue properties, weldability, corrosion resistance, shock resistance and burst testing response. As a result of this testing program, it was determined that Alloy 625 piping produced from spray formed tubulars appears to be a viable substitute for conventionally produced

Alloy 625 piping.

MORAN, Patrick J., Professor, Shifler, D.A., and Kruger, J., "The Passive Behavior of 304 Stainless Steel in Dimethoxyethane Solutions," *Electrochimica Acta*, Vol. 39, No. 16, pp. 2407-2413, 1994.

Series 304 stainless steel, an alloy that is more corrosion resistant in aqueous solutions than carbon steel, was examined to assess the process involved in forming a passive film in an aprotic, nonaqueous solvent such as dimethoxyethane (DME). Electrochemical tests show that the passive ranges of 304 stainless steel in "dry" DME solutions containing  $\text{LiAsF}_6$ ,  $\text{LiClO}_4$  and TBAP were similar. Breakdown of the passive state occurred above 1700-1800 mV (sce). The high anodic potentials were due to the expected superior nature of the air-formed film on 304 stainless steel. Removing the surface oxide film on 304 stainless steel resulted in rapid repassivation in the DME/0.5M  $\text{LiAsF}_6$  solutions at potentials below breakdown. Post-test examinations did not clearly define the passivating mechanism in DME/0.5M  $\text{LiAsF}_6$  solutions but, in DME/saturated  $\text{LiAsF}_6$ , evidence indicated repassivation around 1800-2000mV (sce) by salt film formation. Small water additions to DME/0.5  $\text{LiAsF}_6$  solutions caused slight surface activation of the stainless steel, but no premature breakdown of the passive film. Small acid additions or removal of water below 50-100 ppm triggered surface pitting of the 304 stainless steel above the breakdown potential in DME/0.5M  $\text{LiAsF}_6$  solutions. A critical amount of water appears to be required to passivate the stainless steel surface and neutralize acids produced during electrolyte oxidation.

MORAN, Patrick J., Professor, Kruger, J., Lillard, R.S., and Streniz, C.C., "Effect of Microstructure on Passive Film Formation and Breakdown on Sputter Deposited Al-Ta Alloy Films," Accepted and in press for *Materials Science and Engineering A*.

The role played by microstructural features on the passivation and breakdown processes that lead to pitting has been examined for presumably the first time by the new techniques of dynamic imaging microellipsometry (DIM) and local electrochemical impedance spectroscopy (LEIS). An examination of the passivation of sputter-deposited alloy films of Al-Ta found, contrary to expectations, that the microstructural feature,  $\text{Al}_3\text{Ta}$  precipitates, formed a thicker passive film than the film that forms on the solid solution matrix surrounding the precipitates. The LEIS study of microstructural effects under breakdown conditions found that the film on the  $\text{Al}_3\text{Ta}$  precipitate had a higher capacitance than the dealloyed region

surrounding it, indicating that the film on the precipitate has different properties than the dealloyed region in its vicinity. This difference in film thickness and properties, found by both DIM and LEIS, may be responsible for the breakdown that leads to the pitting that is initiated in the region adjacent to the precipitates.

MORAN, Patrick J., Professor, Lillard, R.S, Kruger, J., and Tait, W.S., "The Use of Local Electrochemical Impedance Spectroscopy to Examine Coating Failures," *Corrosion*, Vol. 51, No. 4, pp. 251-259, 1995.

Local LEIS was used to locate and examine the electrochemical properties of artificial and natural defects in a heat-cured, urea-formaldehyde modified epoxy coating. This coating is used to protect the interior of tin-coated mild steel cans sealed using resistance welding. Samples containing weld coating, nonweld coating, and an artificial defect were immersed in a 0.10M sodium chloride (NaCl) solution buffered to pH 7.2 with boric acid/sodium borate. LEIS maps demonstrated that the coating failed preferentially over the weld seam at a rate greater than that at the artificial defect. Failure was detected by LEIS prior to visual observation of coating failure. Comparable electrochemical impedance spectroscopy (EIS) data generated after each LEIS experiment could be modeled by the conventional two-time constant porous penetration model. LEIS results demonstrated that there were three time constants in this system (coating, defect, and weld seam), indicating that a method for determining local impedance properties is preferable.

MORAN, Patrick J., Professor, Shifler, D.A., and Kruger, "The Passive Behavior of 304 Stainless Steel in PC/Water and DME/Water Mixtures," *Electrochimica Acta*, Volume 40, No. 7, 897-905, 1995.

The passivation and breakdown behavior of 304 stainless steel in propylene carbonate (PC) or dimethoxyethane (DME) mixtures with water and containing 0.5M LiAsF<sub>6</sub> were studied. The air-formed film of 304 stainless steel provides a good passive film that resists breakdown. No pitting was observed in either PC-H<sub>2</sub>O/0.5M LiAsF<sub>6</sub> mixtures or mixed DME-H<sub>2</sub>O/0.5M LiAsF<sub>6</sub> solutions if the polarizations were conducted below the oxidation potential (1800 mV(SCE)) of the hexafluoroarsenate electrolyte. It is apparent that even small amounts of water were sufficient to stabilize the passive film on stainless steel through a probable oxide/oxyhydroxide formation. Pitting of the 304 stainless steel was observed in both mixed organic/water solutions at potentials above the oxidation potential of AsF<sub>6</sub> because of the lack of

passivating mechanisms such as salt film formation, electropolymerization, or oxide/oxyhydroxide formation.

MORAN, Patrick J., Professor, Kruger, J., Shifler, D.A., Scanlon, J.F., "The Passive Behavior of Metals and Alloys in Neutral Non-Aqueous Organic Solvents," Accepted and in press for *Russian Journal of Electrochemistry Special Issue Devoted to Frumkin Centenary*.

The major factor controlling the corrosion of metals and alloys in a given environment is the nature of the protective film. Although the phenomenon of passivity has been observed and characterized in aqueous solutions for over 200 years, the passive film on metals and alloys in non-aqueous, organic solutions is not well understood. Organic solutions are more complex than aqueous solutions and do not act as inert media.

Our research, using various electrochemical and analytical methods, has provided an initial framework for the understanding of passivity in non-aqueous systems and how low levels of water contribute to, or interfere with this passivity. Iron, 1018 carbon steel, 304 stainless steel, nickel and nickel 200 were examined in anhydrous (1-50 ppm water content), neutral, aprotic solutions of propylene carbonate (PC) and dimethoxyethane (DME) with a 0.5 molar supporting electrolyte concentration of either LiClO<sub>4</sub> or LiAsF<sub>6</sub>. Small amounts of water (less than 1000 ppm) were added in some solutions to observe its effect on passivity or passivity breakdown.

In our studies, metals and alloys can passivate in PC or DME solutions by: air-formed oxide-film, chemisorption of the solvent, salt film formation, or electropolymerization of the solvent. Competition among the passivation processes determines the degree to which a metal will passivate and the stability of the passive state. The passivation mechanisms each have regions or conditions of stability which are functions of potential, solvent, electrolyte, salt solubility, interfacial kinetics, and impurities, such as water. If one passivation mechanism can dominate, stable passivity can be obtained. Under conditions where two or more mechanisms are operative, the compatibility and the kinetics of these processes will determine the stability of passivity.

MORAN, Patrick J., Professor, Shifler, D.A., and Kruger, J., "The Effects of Water on the Passive Behavior of 1018 Carbon Steel in Organic Solutions," *Proceedings of the H.H. Uhlig Memorial Symposium*, Electrochem. Soc., Inc., 14-29, 1995.

The passivation and breakdown behavior of 1018 carbon steel in propylene carbonate (PC) or

dimethoxyethane (DME) mixtures with water and containing 0.5M LiAsF<sub>6</sub> were studied. The behavior of the steel in the organic solvent/water mixtures was highly dependent on the organic solvent. The anodic polarization of carbon steel displayed active-passive behavior in 10-90 mole percent PC/H<sub>2</sub>O mixtures and a tenuous degree of stability within the passive range. The anodic polarization of carbon steel displayed no active-passive behavior in 50-90 mole percent DME/H<sub>2</sub>O mixtures and displayed active-passive behavior in 10-30 mole percent DME/H<sub>2</sub>O mixtures. The steel was stable within the passive range of these DME/H<sub>2</sub>O solutions. The breakdown potential of the steel in DME/H<sub>2</sub>O mixtures is more electropositive than the oxidation potential of the DME solvent at all molar ratios.

MORAN, Patrick J., Professor, Kruger, J., and Scanlon, J.F., "Effects of Water Additions on the Passivity of Iron in Dimethoxyethane Solutions," *Journal of Power Sources*, Vol. 54, pp 85-91, 1995.

The effects of trace water additions on the passive behavior of iron in an otherwise anhydrous dimethoxyethane/0.5M LiAsF<sub>6</sub> solution have been studied by electrochemical and surface analytical techniques. The results indicate that the passivity observed in the anhydrous solvent is maintained when small (less than 2000 ppm) concentrations of water are present as a contaminant. Passive current densities increase slightly, but water does not cause any catastrophic interference with the various passivation mechanisms. Water, when present at these levels, actually helps to extend the passive range of iron by several hundred millivolts in this system. This behavior is the result of a complex interplay between iron dissolution and solvent electropolymerization at increasingly anodic potentials. Water is believed to be the component responsible for the localized acidification of areas of active dissolution, which then results in optimal conditions for polymer film formation. This behavior is peculiar to the system of iron in dimethoxyethane/LiAsF<sub>6</sub>.

RAOUF, Raouf A., Associate Professor, "Tailoring the Dynamic Characteristics of Composite Panels Using Fiber Orientation," *International Journal of Composite Structures*, 259-267, Vol. 29, 1994.

One of the advantages of composite structures is the ability to tailor their characteristics by using different lamination schemes. The present paper studies the effects of various lamination schemes on the linear and nonlinear natural frequencies of symmetrically laminated composite panels. The non-linear equations account for geometric nonlinearities and allow finite

displacements and rotations. Numerical studies of a graphite/epoxy panel show that the dominant nonlinearities are cubic and that both the linear and nonlinear natural frequencies of the panel can be altered significantly by changing the orientation of the fiber in the various plies. However, the nonlinear behavior of the panel remains of the hardening type. It is also shown that the strongest nonlinearities are associated with the lowest linear natural frequency whereas the weakest nonlinearities are associated with the largest linear natural frequency.

RAOUF, Raouf A., Associate Professor, "Dynamic Analysis of Orthotropic Toroidal Shells," *Proceedings of the International Conference on Composite Engineering*, pp. 425-426 (extended abstract), 1995.

This paper uses the symbolic manipulator Mathematica to study the dynamics of a unidirectionally reinforced toroidal shell using theory of elasticity, theory of surfaces, and variational principles. The Rayleigh-Ritz procedure is used to approximate the natural frequencies of the torus and the corresponding mode shapes. A numerical study is presented and the modes of vibration of the torus are shown.

RAOUF, Raouf A., Associate Professor, co-author, "Two-Mode Analysis of the Nonlinear Free Vibrations of Orthotropic Shells," *Proceedings of the International Conference on Composite Engineering*, pp. 365-366 (extended abstract), 1995.

The symbolic manipulator Mathematica is used to analyze the two-mode nonlinear free vibration of an orthotropic shell. This expands upon earlier analyses conducted by Raouf on the single mode nonlinear free vibration of an orthotropic shell.

The geometrically nonlinear equations of motion are derived using the Donnell-Mushtari-Vlasov shell relationships.

Next, the method of harmonic balance is implemented by assuming harmonic expansions.

The assumed harmonic expansions are substituted into the discretized equations of motion, and the coefficients of equal harmonics are collected resulting in a set of nonlinear algebraic equations that are solved for the amplitudes and frequencies. The harmonic balance results are compared to direct numerical integration. Numerical solutions are presented for a NARMCO 5605 graphite/epoxy shell with the following geometry and wave numbers: radius  $a = 100$  in, opening angle  $\alpha = \pi/3$  rad, thickness  $h = 1$  in, length  $L = 100$  in,  $k = 1$ , and  $m = 1$ .

RAOUF, Raouf, A., Associate Professor, and Palazotto,

A. N., "Dynamic Stability of Orthotropic Toroidal Shells Under Internal Loads," Proceedings of the 36th AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics, and Materials Conference, 1597-1603, 1995.

This paper studies the nonlinear dynamic stability of fiber-reinforced tori under spatially varying internal loads. The nonlinearity is geometric and of the Von Karman type. Moreover, the torus is assumed to obey the Kirchhoff's assumptions and differential geometry is used to derive the appropriate displacement field. The resulting nonlinear partial differential equations are discretized in the spatial domain using a five-term Galerkin procedure that results in five second order nonlinear ordinary differential equations. These equations are then reduced to a set of four linear differential equations with periodic coefficients. A stability analysis of these equations is performed using the Floquet theory. Numerical results indicate that the instability loads depend on the fiber volume fraction in a nonlinear manner. Furthermore, for the studied cases, results show that stiffening the torus by increasing its fiber volume fraction would enhance its stability characteristics by increasing the instability load until a threshold fiber volume fraction is reached. Increasing the volume fraction beyond that threshold decreases the instability load and accordingly deteriorates the stability characteristics.

RAOUF, Raouf, A., Associate Professor, and Palazotto, A. N., "Nonlinear Dynamic Stability of Pressurized Composite Tori," Proceedings of the 10th ASCE Engineering Mechanics Specialty Conference, 1358-1361, 1995.

A combination of the Galerkin procedure and Floquet theory is used to study the nonlinear dynamics of closed composite tori. A numerical study of unidirectional composite tori indicates a distinct separation between the shell-like and ring-like behavior of the torus. Similar behavior was observed in earlier studies by the author in the frequency domain.

RAOUF, Raouf, A., Associate Professor, and Barton, O., "Analysis of Composite Structures," USNA Report EW-22-94, Annapolis, MD.

The present work contains reports on two different projects that were conducted in the summer of 1994 for the Naval Surface Warfare Center, Carderock Division, Annapolis Detachment:

Chapter 1: Stress Distribution in an Orthotropic Plate Containing an Isotropic Pin: This chapter presents the equations of equilibrium of a fiber-reinforced composite plate with an isotropic pin. It also

presents the solution procedure using complex variables. The results are presented in close analytical form and supplemented by appropriate graphs for use by designers.

Chapter 2: Structural Analysis of Land Based Testing Facility (LBTF) Frame: This chapter presents a computer aided analysis of the existing LBTF frame in the Annapolis detachment. The frame is modeled using a combination of Computer Aided Engineering techniques including solid modeling and the finite element method. The study presents analysis for various loading cases.

RATCLIFFE, Colin, P., Assistant Professor, Roger M. Crane, and Armando L. Santiago, "Fibre Reinforced Polyurethane Composites: Shock Tolerant Components with Particular Emphasis on Armo Plating." Winter Annual Meeting of ASME, San Francisco, November 12-17, 1995.

Structures fabricated with composite materials, such as graphite fibers in thermoset or thermoplastic resins, are typically brittle and have high stiffness. There are many military situations where high-g shocks and ballistic impacts mean using these composites may be unsatisfactory. The U.S. Army is designing a new high-performance armored personnel carrier, and composite materials will be used for armor plating, replacing traditional heavy metal armor. This paper describes a fibre reinforced polyurethane matrix composite panel investigated for its suitability as armor plating.

When a projectile hits conventional composite armor, its energy is dissipated through delamination of the composite. This causes a reduction in the structural properties of the composite. Additionally the moving debris inside the vehicle causes injury to personnel. The new material system reported here consists of 24-oz 5 x 5 S-2 glass fabric infiltrated with a polyurethane having a tensile modulus of 1100 psi and a strain to failure of 300%. The system is mechanically flexible, and has a high inherent energy dissipation potential. When impacted with a high-velocity projectile, delamination is insignificant and its structural characteristics are not significantly degraded. Spalling is eliminated. Also, the high attenuation of the resulting mechanical shock wave within the armor plating reduces the perceived severity of the impact. This is beneficial in raising the crew's level of confidence, and therefore their performance under adverse conditions.

The extensive reinforcement and thick section requirements present some unique challenges. This paper discusses the design and fabrication of a prototype flexible composite panel. Additionally, the experimental results of a dynamic evaluation of the

panel are presented and discussed.

RATCLIFFE, Colin, P., Assistant Professor, Roger M. Crane, and Armando L. Santiago, "Structural and Damping Characteristics of a Flexible Composite Structure," International Symposium on Materials for Noise and Vibration Control," ASME Winter Annual Meeting, 1994, Chicago.

There are many applications where structural components must accommodate significantly large deformations. To allow the components to function effectively while deformed, elements such as flexible couplings may be used. These couplings must transfer in-plane forces and torques, while allowing for a large relative motion across them. Advanced composite materials, such as graphite fibers in thermoset or thermoplastic resins, typically possess high stiffness and relatively low strains to failure in the order of 2 to 5%, depending on fiber orientations. In addition, the mechanical vibration damping of conventional monolithic forms of these structures is relatively low. Therefore, conventional composite materials may not be ideal for constructing couplings.

This paper describes a configuration which is both flexible and structurally supports engineeringly significant loads. This flexible composite system consists of a braided graphite fiber preform infiltrated with different polyurethane systems which have a modulus range of 600-1100 psi, and a strain to failure of 100-400%. These novel composite system possess adequate structural characteristics of strength and stiffness, and the capability to undergo large global deformation, while simultaneously having higher mechanical vibration damping. This paper discusses the fabrication and design of the flexible composite coupling, its mechanical characteristics, and the damping that it provides.

RATCLIFFE, Colin, P., Assistant Professor, Roger M. Crane, and Armando L. Santiago, "Modal Testing of Composite Cylinders," ASME NCA - Vol. 16, Dynamic Characterization of Advanced Materials, H00860 - 1993.

In the manufacturing of composite structures, the material and structure are fabricated simultaneously. As such, specific moduli, strength, and physical characteristics can be readily incorporated into the structure without the necessity of secondary manufacturing steps. One fabrication method amenable to structures with axisymmetric configurations is filament winding. This paper presents recent efforts to increase the damping of one type of axisymmetric structure, i.e. cylinders. The design, fabrication and modal testing of the composite

cylindrical sections with varying structural cross sections are presented. These sections included monolithic sections, cylinders with internal damping treatments, and several variations of a double hollow core configuration. The cylinders tested had internal diameters of 15.9 and 22.9 cm (6.25 and 9 in.) with lengths of 30.5 and 54.6 cm (12 and 21.5 in), respectively. Frequency response data for the "freely suspended" cylinders were obtained by impact testing. This paper reports the results of a vibration analysis of these data using a commercial modal analysis package. The results include natural frequencies, mode shapes and levels of damping, which are compared with those of a baseline aluminum cylinder. All of the composite cylinders tested had loss factors greater than the baseline aluminum, with an increase between 34% to 560%.

RATCLIFFE, Colin P., Assistant Professor, "Reducing the Vibration of a Hollow Superplastically Formed Diffusion Bonded Titanium Spar." Engineering and Weapons Report EW-13-94.

This report presents the results of an experimental investigation into the vibration characteristics of an underwater foil section spar, made from Titanium-6 Aluminum-4 Vanadium (ELI Grade) alloy, using a superplastic forming/diffusion bonding process. The spar had no additional vibration damping treatment, and potentially showed excessive vibration and acoustic radiation. This analysis investigated the use of different damping treatments designed to reduce the vibration characteristics of the component.

The report includes comparative vibration and modal data for several tests, including the original, empty component, and with the spar part and fully filled with sand and polyethylene beads. Since the component is designed for underwater operations, the potential effect of a leak was investigated by repeating one test with water added. The specific design of the spar meant it was particularly amenable to damping. Both the same and polyethylene beads were very effective, and virtually all resonant behavior was eliminated.

The report includes an appendix discussing the physical effects occurring when polyethylene beads are used as tuned absorbers in a rib-reinforced component.

RATCLIFFE, Colin P., Assistant Professor, "Nonlinear Analysis of a Shock Test of a Vibration Isolation Mount." Engineering and Weapons Report EW-06-94.

The load deflection characteristics of a rubber and flange vibration isolation mount show that during the deformation of the rubber element the stiffness is



essentially linear. This can be for relatively large displacements. However, once the rubber "bottoms out", the stiffness is highly nonlinear, and approaches that of the flange alone.

Earlier work examined a mount undergoing a standard Department of Defense shock test and assumed linearity. The predicted deformations of the mount were outside the linear range, and therefore this report undertakes a full nonlinear analysis. The method used is a finite difference algorithm. Since the results needed are displacement, velocity and acceleration, a 2-point algorithm using all three variables is used, as opposed to the numerically faster 3-point algorithms which calculate only one parameter.

Excellent agreement between predicted and measured mount deformation is reported.

WU, Chih, Professor, co-author, "Engineering Education: Future Directions," Proceedings of the 1994 ASEE Summer Annual Meeting, Edmondton, Alberta, Canada, June 25-28, 1994.

The future of engineering education as viewed by the authors is presented. A general brief review of engineering education in the United States and other countries is given and a proposal made that engineering educators and universities must take a leadership role in the packaging of new, innovative programs. The importance of the role of students, faculty, curricula, and universities is discussed. A case is made for more design and manufacturing as well as the need for more hands on laboratory experience. a strong plea is also made to support "continuing education" for all engineers.

WU, Chih, Professor, "Power Optimization of an Endoreversible Stirling Cycle with Regeneration," *Energy: The International Journal*, 19, 125-133, 1994.

An optimal power analysis is conducted on an endoreversible Stirling cycle with perfect regeneration. The endoreversible cycle is one in which the external heat transfer processes are the only irreversible processes of the cycle. Maximum power and efficiency at maximum power are obtained for the cycle based upon higher and lower temperature bounds. These results provide additional criteria for use in the study and performance evaluation of Stirling engines.

WU, Chih, Professor, "Power Potential of a Terrestrial Solar-radiant Stirling Heat Engine," *International Journal of Ambient Energy*, 15, 131-140, 1994.

The output power and thermal efficiency of a finite-time optimized terrestrial solar-radiant Stirling heat engine is studied. The thermodynamic model adopted

is a regenerative gas Stirling cycle coupled to a heat source by radiant heat transfer. Both the heat source and heat sink have infinite heat capacity rates. Mathematical expressions for maximum power and efficiency at maximum power are obtained for the cycle based on higher and lower temperature bounds. The result of this theoretical work provide a base line criteria for use in the performance evaluation and design of such engines as well as for use in performance comparisons with existing terrestrial solar power plants.

WU, Chih, Professor, Co-author, "Optimal Performance of a Geothermal Heat Engine Driven Heat Pump System," *Energy: The International Journal*, 19, 1219-1224, 1994.

A geothermal heat powered, low temperature Rankine cycle is suitable for the operation of a conventional mechanical compression heat pump cycle in providing heating and cooling loads. This system is analyzed using a finite-time thermodynamic approach. The only irreversibilities are associated with heat transfer between the system and surrounding thermal reservoirs.

WU, Chih, Professor, "The Effect of Combustion on a Power Optimized Endoreversible Dual Cycle," *International Journal of Power and Energy Systems*, 14, 98-103, 1994.

The power potential of an endoreversible Dual cycle with combustion is analyzed and optimized. The endoreversible cycle is one in which the heating process by combustion and the heat-removing process to the surroundings are the only irreversible processes in the cycle. This paper provides another criteria besides thermal efficiency, mean effect pressure, and detonation for use in the evaluation of the performance and the suitability of spark ignition and diesel engines which have been modeled thermodynamically using the Dual air standard cycle.

WU, Chih, Professor, "Naval Ship Waste Heat Recovery," *International Journal of Power and Energy Systems*, 14, 84-86, 1994.

Two kinds of advanced waste heat recovery systems which utilize waste heat from a ship's auxiliary service power systems are studied in this paper. One is a pressurized water flash heat recovery system, which is deemed to be suitable for utilizing the exhaust gas waste heat of a gas turbine engine, and the other is a pressurized water flash and steam compression system suitable for utilizing the waste heat of a diesel engine. Analyses are carried out to depict their potential applications.

WU, Chih, Professor, "Maximum Obtainable Specific Cooling Load of a Refrigerator," *Energy Conversion and Management*, 36, 7-10, 1995.

The maximum obtainable specific cooling load of an endoreversible Carnot refrigerator is presented in this paper. The endoreversible Carnot refrigerator is a modified Carnot cycle. The only irreversibilities of the cycle are associated with the heat transfer between the refrigerator and the surrounding thermal reservoirs. The specific cooling load is the cooling load per unit of the total surface area of the heat exchangers. The maximum obtainable specific cooling load provides a thermoeconomic criterion for use in the evaluation of the performance of a real refrigerator.

WU, Chih, Professor, "Maximum Obtainable Power of a Carnot Combined Power Plant," *Heat Recovery Systems and CHP*, 15, 351-355, 1995.

Maximum obtainable power of a combined endoreversible Carnot cycle is analyzed. It is found that there is a bound on the obtainable power of real combined cycles. This bound provides a new theoretical criterion for the evaluation of existing combined power generating systems or for influencing the design of future combined heat engines.

WU, Chih, Professor, "Design Considerations of Primary Performance Parameters for Irreversible Refrigeration Cycles," *International Journal of Ambient Energy*, 16, 17-22, 1995.

The endoreversible cycle model of refrigerators is extended to an irreversible cycle model which includes the irreversibility of finite-rate heat transfer and the internal irreversibility of the working fluid. The cycle model is then used to analyze the optimal performance of refrigerators. For a specified cooling rate and a given overall heat transfer area of two heat exchangers, minimizing the coefficient of performance of refrigerators leads to an optimal ratio of the two heat exchanger areas.

WU, Chih, Professor, "Maximum Obtainable Specific Power of High-temperature Waste Heat Engines," *Heat Recovery Systems and CHP*, 15, 23-28, 1995.

An endoreversible Carnot cycle is presented in this paper for a heat engine using high temperature waste heat. The endoreversible Carnot cycle is a modified Carnot cycle where the heat transfer between the heat engine and its surroundings are the only irreversible processes. Since the energy input to the heat engine is free, the cost of the output power of the heat engine depends mainly on the size of the heat exchangers. A

specific power, power per unit area of heat exchanger surface area, is adopted as the object function for the performance analysis of the heat engine. The relation between the maximum obtainable specific power and the temperature range in which the high temperature waste heat engine operates is found.

WU, Chih, Professor, "Energy Simulation Analysis of Shipboard Centrifugal Chillers," *International Journal of Power and Energy Systems*, 15, 1-3, 1995.

Parametric studies on design component variations from a base case to delineate the effects of design variations on a shipboard centrifugal chiller is performed. It was found that improved heat exchangers could significantly reduce an air conditioning system's power demand over a wide range of operating conditions. As expected, a centrifugal chiller with a variable speed compressor exhibited a large improvement in annual coefficient of performance values than that of a single speed compressor. The performance of a new 175 tons heat pump design was also simulated.

WU, Chih, Professor, "Maximum Specific Power Output of a Two-stage Endoreversible Combined Cycle," *Energy: The International Journal*, 20, 305-309, 1995.

The optimal performance of a two-stage endoreversible combined cycle is investigated for steady state operation. The cycle efficiency at maximum specific power output equals the Curzon-Ahlborn efficiency, whereas the maximum specific power output of the cycle is, in general, smaller than that of a single stage endoreversible cycle operating over the same temperature range. Optimization problems concerning temperatures of the working fluid and heat transfer areas of the heat exchangers are discussed.

WU, Chih, Professor, "Power Optimization of an extra-terrestrial solar radiant Stirling Heat Engine," *Energy: The International Journal*, Volume 20, No. 6, 523-530, 1995.

The power output and thermal efficiency of a finite time, optimized, extra terrestrial, solar radiant Stirling heat engine have been studied. The thermodynamic model adopted is a regenerative gas Stirling cycle coupled to a heat source and heat sink by radiant heat transfer. Both the heat source and sink are assumed to have infinite heat capacity rates. Expressions are obtained for optimum power and efficiency at optimum power for a cycle based on higher and lower temperature bounds.

WU, Chih, Professor, "Performance of a Heat Driven Endoreversible Cooler," *Energy Conversion and Management*, Volume 36, No. 11, 1053-1057, 1995.

Heat driven cooling becomes economically attractive when there is an available inexpensive heat source at low temperature. The maximum obtainable cooling load and the maximum obtainable coefficient of performance of a heat driven endoreversible cooler are analyzed in this paper. The endoreversible cooler is an internally reversible but externally irreversible device which exchanges heat with the surroundings. The maximum obtainable cooling load and maximum obtainable coefficient of performance of the cooler provide a theoretical new basis for the evaluation of the performance of existing heat driven coolers.

WU, Chih, Professor, "Performance of Solar Pond Thermoelectric Power Generators," *International Journal of Ambient Energy*, Volume 16, No. 2, 59-66, 1995.

A real thermoelectric power generator utilizing heat from a solar pond is proposed. The generator is treated as an external and internal irreversible heat engine. The specific power output of the generator is analyzed and compared with that of the Carnot, endoreversible, and external reversible thermoelectric heat engines.

WU, Chih, Professor, "Optimization of Submarine Thermoelectric Coolers Incorporating Finite-time Thermodynamics," *International Journal of Power and Energy Systems*, Volume 15, No. 2, 42-47, 1995.

This paper examines from a theoretical stand point the characteristics of thermoelectric coolers when applied to finite-time thermodynamics. In addition to the thermoelectric cooler, heat exchangers are added which connect it to a source and a sink. Using this setup, three methods of optimization are examined: maximum coefficient of performance, maximum cooling rate, and maximum temperature difference.

WU, Chih, Professor, "Performance Potential of a terrestrial solar radiant Ericsson Power Cycle from

Finite-time Thermodynamic Analysis," *International Journal of Power and Energy Systems*, Volume 15, No. 2, 78-84, 1995.

The power output and thermal efficiency of a finite-time optimized terrestrial solar radiant Ericsson heat engine is studied. The thermodynamic model adopted is a regenerative gas Ericsson cycle coupled to a heat source by radiant heat transfer. Both the heat source and sink have infinite heat capacity rates. Mathematical expressions for maximum power and efficiency at maximum power are obtained for the cycle based on higher and lower temperature bounds. The results of this theoretical work provide a baseline criteria for use in the performance evaluation and design of such engines as well as for use in performance comparisons with existing terrestrial solar power plants.

WU, Chih, Professor, Co-author, "Optimal Performance of a Heat-Engine-Driven-Heat Pump System Utilizing Low Grade Thermal Energy," *Proceedings of the ASME Thermodynamics and the Design, Analysis, and Improvement of Energy Systems Conference*, 33, 271-275, 1994.

A low temperature Rankine cycle utilizing low grade thermal energy is used to drive a conventional mechanical compression heat pump cycle, providing heating and cooling loads. Typically, the performance of such a system would be modeled using Carnot cycle heat engine driving a Carnot heat pump. The efficiencies of real cyclic devices do not approach those of Carnot devices due to the many irreversibilities associated with each of the processes. To achieve acceptable rates of energy transfer, the heat transfer processes must occur through finite temperature differences and in finite time, making these processes irreversible. This system is analyzed using a finite-time thermodynamic approach where the only irreversibilities are associated with heat transfer between the system and surrounding thermal reservoirs. This approach provides more realistic upper bounds for the performance of such a device and information regarding optimum working fluid temperatures.

## Presentations

BARTON, Oscar, co-author, "A Study of the Dynamic Characteristics of Composite Plates with Variable Thickness," 24th Midwestern Mechanics Meeting, 3-5 October 1995, Ames, Iowa.

DAVIS, Gregory W., Assistant Professor, "The Effect

of a Regenerative Braking System in the AMPhibian Hybrid Electric Vehicle", 29th Intersociety Energy Conversion Engineering Conference, 9 August 1994.

DAVIS, Gregory W., Assistant Professor, and Wu, C., "Optimal Performance of a Heat Engine-Driven-Heat

Pump System Utilizing Low Grade Thermal Energy", 1994 International Mechanical Engineering Congress and Exposition, 6 November 1994.

DAVIS, Gregory W., Assistant Professor, and Madeka, F. C., "The Effect of Regenerative Braking on the Performance and Range of the AMPhibian II Hybrid Electric Vehicle", 1995 SAE International Congress and Exposition, 2 March 1995.

FLACK, K.A., Assistant Professor, Johnston, J.P., "Advances in Three-Dimensional Turbulent Boundary Layers with Emphasis on the Wall-Layer Regions," 1994 ASME Engineering Division Summer Meeting, Lake Tahoe, NV, June 1994.

GRANGER, Robert A., Professor, "The Dynamic Behavior of a Line Array of Cylindrical Charges Descending and Being Towed in Various Sea States," 2nd European Fluid Mechanics Conference, Warsaw, Poland, 20-24 September 1994.

GRANGER, Robert A., Professor, "Coherent Structure of Turbulent Shear Flow," 2nd European Fluid Mechanics Conference, Warsaw, Poland, 20-24 September 1994.

GRANGER, Robert A., Professor, "Vortex Motions," Code 80 Seminar, NSWC, Annapolis, Maryland, 17 November 1994.

HASSON, Dennis F., Professor, co-author, "Commercial Development of Fibrous Monolithic Ceramics," Annual Meeting, American Ceramics Society, Cocoa Beach, Florida, January 1995.

JOYCE, James A., Professor, "Evaluation of Constraint Effects on Fracture in Nuclear Pressure Vessel Steels," Third International Conference on Material Science Problems in NPP Equipment Production and Operation, Moscow - St. Petersburg, 17-22 June 1994.

JOYCE, James A., Professor, "Effects of Constraint on Upper Shelf Fracture Toughness," ASTM National Symposium on Fracture, Idaho Falls, ID, 1 July 1994.

JOYCE, James A., Professor, "Surface Crack Cleavage Fracture Toughness Experiments - Progress Report, Workshop on Constraint Effects in Fracture, U.S. Nuclear Regulatory Commission, Bethesda, Maryland, 28-29 March, 1995.

JOYCE, James A., Professor, "Short Crack Fracture Toughness and the Transition to Cleavage," Workshop on Constraint Effects in Fracture, U.S. Nuclear Regulatory Commission, Bethesda, Maryland, 28-29

March 1995.

MINER, Steven M., Associate Professor, "Fundamentals of Fluid Mechanics," Computational Fluid Dynamics Using Finite Elements, Short Course at University of Maryland, 14-16 November 1994.

MORAN, Angela L., Assistant Professor, "Intelligent Spray Forming, 41st Sagamore Conference, Boston, Massachusetts, 29 August 1994.

MORAN, Patrick J., Professor, "Lecture Series on Mechanisms of Corrosion," (4 lectures), Naval Surface Warfare Center, Carderock Division, Annapolis, Maryland, June 1994.

MORAN, Patrick J., Professor, "Kinetics of Corrosion Reactions," Knolls Atomic Power Laboratory, Schenectady, New York, 15 August 1994.

MORAN, Patrick J., Professor, "Nondestructive Evaluation of Corrosion and Electrochemical Impedance Spectroscopy," Knolls Atomic Power Laboratory, Schenectady, New York, 17 August 1994.

MORAN, Patrick J., Professor, "Effects of Water on the Passive Behavior of 1018 Carbon Steel in Organic Solutions," with D.A. Shiftler and J. Kruger, Electrochem. Society, Inc., Meeting, Miami, Florida, 11 October 1994.

MORAN, Patrick J., Professor, "Kinetics of Corrosion Reactions," University of Virginia, Charlottesville, Virginia, 5 June 1995.

MORAN, Patrick J., Professor, "Complications of Electrochemical Test Methods and Small Amplitude Polarization Methods to Overcome Them," University of Virginia, Charlottesville, Virginia, 7 June 1995.

PALMER, Sheila C., Assistant Professor, "Dual-pressure Absorption Cycles: The Second Law and Working Fluids," seminar given for the faculty at the University of Virginia, Charlottesville, Virginia, 3 March 1995.

RAOUF, Raouf A., Associate Professor, "Dynamic Analysis of Composite Toroidal Shells," International Conference on Composite Engineering I, New Orleans, Louisiana, August 1994.

RAOUF, Raouf A., Associate Professor, "Dynamics of Pressurized Toroidal Shells," 36th AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics, and Materials Conference, New Orleans, Louisiana, April 1995.

## MECHANICAL ENGINEERING

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RATCLIFFE, Colin P., Assistant Professor,  
"Experimental Modal Analysis," A short course given  
to the Acoustical Society of America, June 1994.

RATCLIFFE, Colin P., Assistant Professor, Crane,  
Roger M., "Flexible Composites: Material and  
Structural Damping Experimental Characterization,"  
ASM/TMS Material Exposition, Pittsburgh,  
Pennsylvania, 18-21 October 1994

# Naval Architecture, Ocean, and Marine Engineering

Commander James A. Mette, Jr., USN  
Chair

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Scholarly research and continued professional development are key to maintaining the high standards of excellence of any academic program. By remaining current in their respective disciplines, faculty bring a "state of the art" sense to the curricula, helping to generate a greater level of interest by the students. Research conducted by the Midshipmen, complements the efforts of faculty and enables students to make contributions, often significant, to their field of interest.

During the Academic Year 1994-1995, the Naval Architecture, Ocean and Marine Engineering (NAOME) Department conducted scholarly activities in each of the three disciplines. Research, funded and independent, was accomplished by civilian faculty, military faculty and midshipmen, in a broad range of topics, utilizing the excellent laboratory and computer facilities available at the U.S. Naval Academy. Projects were accomplished in cooperation with other academic institutions, and various Navy and other government activities. Faculty research areas included ship stability, ship structures, open ocean wave studies, wave generation in the marginal ice zone near the polar cap, dosimetry and thermophotovoltaics, to name a few.

Midshipman research included topics such as propellers, planing hull studies, ship structures, use of artificial reeds to reduce beach erosion, gas augmentation of a Brayton cycle and nuclear material disposition. Funding sources to support this research include the National Science Foundation, National Academy of Sciences, National Academy of Engineering, Department of Energy, Office of Naval Research, National Oceanographic and Atmospheric Administration, U.S. Army Corps of Engineers, Defense Nuclear Agency, Shell Oil, Mobil Research & Development Corporation, Johns Hopkins University, University of North Carolina-Charlotte and numerous Department of the Navy activities.

The department also continued its active participation in a number of national and international professional society meetings and conferences. The broad range of topics include: experimental techniques for modeling ship stability, wave properties and their influence on beaches and structures, underwater vehicles to clean ship hulls and soil remediation (the removal of heavy metals and other contaminants from soil).

## Sponsored Research

### Implementation and Testing of a Four Chip LiF Copper Doped TLD with Neural Network Analysis

Researchers: Lieutenant James R. Cassata and  
Professor Martin E. Nelson  
Sponsor: Naval Surface Warfare Center

The Navy is considering the replacement of their current thermo-luminescent dosimeter (TLD) system with a new and more sensitive one. A series of tests must be done to see that the new dosimeter still meets the fundamental requirements of a personnel dosimeter. To do the tests an algorithm must be developed to find the dose equivalent from the TLD chip responses.

Traditional algorithms use empirical curve fits and decision trees. In some mixed fields these algorithms miss part of the radiation field. National Voluntary Accreditation Programs (NAVLAP) for dosimetry processors have become more stringent in their requirements. More sophisticated prediction techniques of the dose equivalent are needed in the dosimetry field.

to obtain more precise readings and to comply with NAVLAP standards.

Neural networks are a form of artificial intelligence used in pattern recognition, event prediction, and relationship identification. Very little work has been done in applying neural networks to dosimetry. This research is working toward the development of a neural network to replace traditional empirical algorithms used in dose prediction. It is hoped that the neural net will prove to be a more precise way of determining the dose equivalent from chip responses.

There are a wide variety of neural networks that can be used. A back propagation net will be employed first. The nets must be trained from known response data. This entails a large number of experiments to dose map the TLD's chip response.

In summary, this research can be broken down into four parts. First, an entire dose mapping will be done

to categorize the TLD's chip response. Second, an approach will be developed for dose mapping with a smaller more manageable number of experiments. Third, the neural network will be developed, trained, and double blind tested. A traditional algorithm will also be developed for comparisons with the net. Fourth, a battery of tests will be compiled and formalized from ISO, ANSI and other standards in the field. Once written, this test plan will be performed in side by side testing of the old and new dosimeter to see that the new TLD still meets the fundamental requirements of a dosimeter and is competitive with the old TLD.

To date, the first and second parts of the research have been completed. The traditional algorithm (in part 3) has also been developed. Work is commencing on the neural network.

## **Thermodynamic Mixing of Real Gases and Gas/Liquid Mixtures and the Effect on Enthalpy and Entropy**

Researcher: Dr. Martin Cerza

Sponsor: Office of Naval Research

The purpose of this proposed investigation is to evaluate the ability of an ideal gas to modify the compressibility and decrease the enthalpy departure of a real gas (working fluid) for the purpose of increasing the power output and/or the thermal efficiency of modern power cycles. The investigation will be theoretical and will answer several posed questions

pertaining to the mixing of real gases and gas/liquid systems. Conclusions will be drawn in order to determine whether or not further experimental or theoretical investigations are warranted. The theoretical investigation will entail classical and possibly statistical thermodynamics.

## **Boiling and Condensation Thermal Performance for Non-CFC Refrigerants with and without Enhanced Heat Transfer Surfaces**

Researcher: Dr. Martin Cerza

Sponsor: Naval Surface Warfare Center-Carderock Division

An International agreement in 1992 called the Montreal Protocol has set the stage for the phasing out of Ozone harmful refrigerants, ChloroFlouroCarbons (CFC's) and has established guidelines for phasing in HydroFlouroCarbons (HFC's) which are Ozone safe. In its efforts to comply with the Montreal Protocol, the US Navy will be redesigning its shipboard refrigeration facilities. This means that phenomena associated with the thermal performance of refrigeration facilities, namely, boiling and condensation heat transfer will

have to be examined with regards to the new HFC refrigerants. In addition, in order to make the new equipment lighter and more compact, enhanced heat transfer surfaces are also being developed. These new surfaces show great promise for enhancing heat transfer on boiling and condensation surfaces. This investigation studies the phenomena involved with new HFC refrigerants on existing and enhanced boiling and condensation heat transfer surfaces.

## **Intact Ship Stability Criteria Revision**

Researchers: Professor Roger H. Compton and Professor Bruce C. Nehrling

Sponsors: Naval Sea Systems Command and United States Coast Guard

An ongoing international effort to review, improve, and update ship stability criteria has employed physical scale modeling, analytical modeling, and full scale sea trials to understand and develop criteria which insure adequate safety over a ship's life.

The U.S. Naval Academy Hydromechanics Laboratory (NAHL) has been involved in this criteria development process primarily in the performance of physical scale model experimentation in wind, waves, and combined wind and wave environments. This NAHL effort, which began during the summer of 1993, is an ongoing effort.

During the summer of 1994, following full scale sea trials on the USCGC BOUTWELL, a HAMILTON Class cutter, in the Gulf of Alaska during January of 1994, the NAHL conducted an experimental program intended to recreate, in the laboratory, selected conditions experienced at sea by the BOUTWELL. Six specific data runs from the sea trials were simulated in the 380 foot towing tank at NAHL. Three involved testing at zero forward speed in wind and wave conditions at various relative headings; three involved irregular wave testing at Froude scaled ship speeds in head and following sea conditions. Pitch, roll, and vertical acceleration data were acquired from the model

in the zero speed wind and wave tests; pitch and heave data were acquired from the at-speed tests.

Fundamental roll dynamics parameters such as natural periods, decay coefficients, and virtual inertia for ships are derived more easily from model test procedures than from full scale, at-sea testing. To assist the computer analysts who are developing FREDYN, a state-of-the-art, time domain ship motion and stability program, several such "simple" experiments were conducted using the same HAMILTON Class cutter model.

A number of sallying experiments were conducted at zero speed to quantify the effects of the NAHL soft restrain system on roll motion dynamics, and the influence of various underwater appendages. Sallying experiments over a range of forward speeds were conducted to examine speed effects. Zero speed beam sea rolling in long crested, regular waves was performed for a variety of model loadings, wave steepness, and wave frequencies. Zero speed rolling in long crested irregular waves was done with and without beam winds to study the damping effect of wind.

Analysis and correlation efforts between model data and full scale trial data are ongoing. Additional model testing is planned for the summer of 1995.

## **Wave Groups and Breaking Waves in Random Seas**

Researchers: Professor Thomas H. Dawson,

Associate Professor David L. Kriebel and

Louise A. Wallendorf

Sponsor: Office of Naval Research

Wave groups and wave breaking in random deep-water seas are being studied experimentally using the U.S. Naval Academy's 380 foot towing tank. Results to date have been compared with theoretical work that accounts for non-linear effects on crest amplitudes. This work is

continuing under Office of Naval Research (ONR) sponsorship with further attention to be directed towards an understanding of the interrelationship between wave breaking and wave groups.

## **The Design and Construction of a High Temperature Photon Emitter for a Thermophotovoltaic Generator**

Researchers: Assistant Professor Mark J. Harper and Associate Professor Keith W. Lindler

Sponsor: Department of Energy

The purpose of this project is to design and fabricate a combustor/emitter compatible with a Department of Energy furnished thermophotovoltaic (TPV) power module. This unit is to be totally self-sufficient with all required ancillary equipment powered by the TPV cells.

Responsibility for the fuel selection, flame control, temperature effects on combustor/emitter materials, gas burner design and emitter coatings belonged to the United States Naval Academy (USNA) designers. Care was taken in choosing the emitter coating since they



may enhance the spectral emittance from the emitter surface. Dr. Lindler developed a computer model of the heat transfer characteristics of the TVP system. The USNA team designed a prototype combustor/emitter and tested it with both a glass and a steel emitter at various air/fuel ratios. Results from these tests were

used to refine and validate the computer model. This refined version of the computer model has been used to design a high temperature emitter capable of achieving a near constant emitter temperature of 2700 degrees F. The high temperature TPV system should be constructed and tested by June 1995.

### **Wave Transformation Measurements from SUPERTANK**

Researchers: Associate Professor David L. Kriebel  
Visiting Research Instructor Jennifer K. Waters  
Sponsor: National Science Foundation

The SUPERTANK Data Collection Project, sponsored by the Army Corps of Engineers, was conducted during August and September 1991 at the Wave Research Laboratory of Oregon State University. The goal of the project was to collect data on nearshore waves and sediment transport under controlled conditions at prototype scale in a large wave tank. Over 30 investigators from the U.S. and several other countries took part in this project. The team from the Naval Academy included Dr. Kriebel from the Ocean

Engineering Program, Ms. Louise Wallendorf from the Hydromechanics Laboratory, and two 1/C Midshipmen. The goal of the Naval Academy team was to measure wave conditions in the so-called swash zone between the still water shoreline to the upper limit of wave runup. Preliminary data analysis has been completed and a draft data report has been published by the Army Corps of Engineers. Additional results have been presented in two conference papers.

### **Wave-Current Loading on a Production Caisson**

Researchers: Assoc. Prof. David L. Kriebel  
Visiting Research Instructor Jennifer K. Waters  
Sponsors: Mobil Research and Development Corporation  
and National Science Foundation

An experimental investigation is being conducted to document extreme loading on a vertical production caisson (30-inch diameter steel pile containing a producing oil well) in waves and currents with depth-limited breaking waves. This work was motivated by recent failures of these structures during Hurricane Andrew in the Gulf of Mexico. In addition, there are continued uncertainties in the way wave-current interactions are treated in wave force calculations as recommended by the American Petroleum Institute. Several sets of laboratory experiments have been

conducted in a large wave tank in order to provide design guidance. Tests were conducted at a 1-to-20 scale with a single vertical cylinder instrumented to measure in-line and transverse forces and overturning moments. Tests simulated "shallow water" Gulf of Mexico conditions with a full-scale water depth of 50 feet and with wave heights of up to 40 feet. Presently, analysis of acquired experimental data along with comparisons to predictive loading methods are being performed.

### **Model Testing of a Deep Water Compliant Tower**

Researchers: Associate Professor David L. Kriebel and  
Visiting Research Instructor Jennifer K. Waters  
Sponsors: Shell Oil and National Science Foundation

Laboratory tests have been conducted on a 1-to-100 scale model of a compliant offshore tower under deep water wave loading conditions. Tests were performed in both regular and irregular waves, and measurements were obtained of the structure's deck deflection, base shear force, and overturning moment about the base. Results are presented in the form of dynamic

amplification factors with measured values compared to simplified theory based on a Single-Degree of Freedom (SDOF) analysis. In general SDOF analysis is shown to adequately describe the structural response in regular waves as well as the RMS structural response in random waves. The extreme response in random waves is found to occur just after passage of large waves and is

the result of the impulsive nature of the extreme wave

loading.

## **Development of a Space Mission Computer Aided Design Program**

Researcher: Associate Professor Thomas J. Langan

Sponsor: Naval Space Command

The purpose of this research is to develop a window-based software system that will guide midshipmen through the design of a space mission. Midshipmen-designers will be expected to provide the rationale for design decisions, choice of hardware and components, and provide the algorithms for synthesis and analysis. The computer will provide historical and technical data bases, computations, simulations, and interactive graphics; it will also provide an archive for the developing design.

Our studies have lead to the identification of several data bases that the midshipmen will need: spacecraft attributes and missions, sensors, launch vehicles, questions for guiding the design, bibliography, and a design program manual. The initial plan for the space mission analysis was to use the space mission analysis and design process laid out by Larson and

Werty; however, further study of their approach revealed that it did not break down directly into a synthesis and an analysis break down of functions. Our research did lead to a way to break down the design system into pure synthesis steps which allow stepwise and multi-stepwise analysis. This new organization of the Larson and Werty process will form the basis for the design program. The program mechanics are based on the design of previous design systems; the use of windows to guide the midshipmen through the design process is a new technology to this researcher. There are four areas in which we anticipate progress during the next phase of this program: demonstration that the window system will do the job, development of working data bases, completion of the flow diagram for the design program, and completion of some useful working segments.

## **Wave Transformation and Beach Runup**

Researcher: Associate Professor Robert H. Mayer

Sponsor: U.S. Army Corps of Engineers

Wave runup remains a subject of concern in the design of beach fills and in beach profile modelling. The runup is defined here as the maximum vertical excursion of the wave uprush on the beach above the still-water level datum. For beach profile modelling, runup is of importance because it defines the landward limit of both the wave action and the sediment motion. As a result, an assessment of wave runup is required to properly design the elevation of a beach fill cross-section to prevent or minimize wave overtopping. Likewise, an estimate of wave runup is required to accurately predict the elevation and landward extent of the erosion scarp on an eroding beach. This may, in turn, dictate the crest elevation and width of an artificial dune designed to provide storm protection.

Previously, a computationally-simple formula for the calculation of wave runup on bi-linear slopes was

obtained by combining two widely-used methods of predicting wave runup, i.e., the Hunt Formula and the "effective" slope method of Saville. The resulting quadratic equation can be solved either analytically or numerically and was shown successful for predicting wave runup on bi-linear slopes.

The purpose of this project was to extend this integrated method to beaches with curvilinear profiles and/or composite beach-face slopes. Experimental verification of this approach was accomplished in the Coastal Engineering Wave Basin of the USNA Hydromechanics Laboratory. Wave runup was measured for numerous wave forms (both regular and irregular waves) on various beach profiles. The measured runup values compared favorably with values predicted by the theoretical equation.

## **Development of a Lightweight Portable Fast Neutron Detector Using Composite Materials**

Researchers: Lieutenant Marshall G. Millett, USN and  
Professor Martin E. Nelson  
Sponsor: Defense Nuclear Agency

Research is being conducted to solve a problem faced by nuclear weapon treaty verification teams. In order to ensure compliance with international nuclear weapon treaties, signers are permitted to inspect each other's nuclear weapon facilities. To minimize the intrusiveness of inspections, the non-presence of a nuclear weapon can be verified by the use of neutron radiation detection equipment. Under the Intermediate Nuclear Forces Treaty (INF), a neutron detector was developed specifically for the purpose of verifying the non-presence of nuclear warheads. Under the more recent START Treaty, the On-Site Inspection Agency (OSIA) established a requirement for an improved detector that would be commercially available, smaller, and lighter than the current detector. The Defense Nuclear Agency subsequently conducted a survey of commercially available detection equipment in 1993 and concluded that available detectors offer no significant advantages over the detector now in use. A better detector is still needed. The present research involves exploiting the relatively high scattering cross

section of hydrogen (near 20 barns below 10 keV) in a hydrogenous gas filled proportional counter to develop a new lightweight detector. Because of hydrogen's reasonable scattering cross section at high energies, it does not require significant moderation, which should result in a lighter detector. Furthermore, by using a high pressure cylinder constructed of a suitable composite material, both the safe containment of a high pressure gas and adequate moderation is achieved by a suitable composite vessel wall material.

Research activities consist of modelling for preliminary detector design, testing of a prototype detector for model validation, and final modelling for design optimization. Currently, the research is still in the computer modelling stage using the Monte Carlo N-Particle (MCNP) transport code. Several preliminary designs have been developed which show significant size and weight savings over the current detector. Prototype testing will be conducted in the Summer and Fall, 1995. This research will be concluded in February, 1996.

## **On the Nonlinear Motions of Moored Ships**

Researcher: Asst. Professor Sarah E. Mouring  
Sponsor: Naval Facility Engineering Service Center, Port Hueneme, California

The problems caused by excessive motions of single point moored (SPM) ships are associated with the hawser configuration. These motions can cause the loading on a hawser to exceed the snap load; therefore, such motions are critical to the safety of the mooring. However, ship motions are difficult to predict due to the nonlinearity of the equations of motion. Recently, experimental and theoretical studies of the nonlinear motions of SPM supertankers have been performed by Wichers and de Kat. Since supertanker motions are relatively slow, many of the nonlinear terms in the hydrodynamic force equations were neglected. However, this assumption needs to be verified. Therefore, the purpose of this study was to determine the sensitivity of the nonlinear motions of a ship to each one of these neglected higher order terms. The nonlinear equations of motion were developed by Prof. Michael E. McCormick and Asst. Prof. Sarah Mouring,

where all of the nonlinear terms were included. These modified equations have been simultaneously solved by developing a computer program using the computer language, Advanced Continuous Simulation Language (ACSL). The equations of motion were applied to both combatant and commercial ships using the computer program. Results show that there is a great level of sensitivity of the nonlinear motions to each neglected higher order term. Therefore, these higher order terms should not be neglected in the nonlinear analysis of ship motions. Finally, for several different scenarios, results from this study were compared with moderate success to results from the Navy's mooring design software package, AQUA. However, the computer program was found to be very sensitive to the numerical accuracy of the programming language, ACSL. This problem requires further investigation.

## **An Analysis into the Uncertainty of Stiffened Panel Ultimate Strength**

Researcher: Assistant Professor Sarah E. Mouring  
Sponsor: Naval Surface Warfare Center, Carderock Division

The objective of this project is to develop a numerical modeling technique which can predict accurately the structural stability of a tee-stiffened panel subjected to both in-plane and out-of-plane loading. Results from this numerical model will be compared to results from structural testing of a series of stiffened panels, performed by Professor Gregory J. White in the USNA Ship Structures Laboratory. These comparisons will help quantify any modeling errors. All information gained will be used in the development of a reliability-based design procedure.

ABAQUS finite element software was chosen for the numerical modeling of the panels. A non-linear

model of the tee-stiffened plate panel was developed using approximately 400 plate and beam elements. The model was loaded with in-plane compression and analyzed. Comparing the finite element results to the experimental results showed that the model performed very well in the pre-buckling region. However, ABAQUS was unable to solve for the post-buckling behavior due to the nonlinearity of the problem. More investigation is needed into alternative solution techniques before this problem can be resolved. Finally, the second part of this project has just started: the effect of out-of-plane loading on the stability of the panel.

## **Investigation of Multi-Function Radiac with Neutron Probe**

Researcher: Professor Martin E. Nelson  
Sponsor: Naval Surface Warfare Center, White Oak, Maryland

The energy and angular response of the multi-function Radiac with neutron probe has been investigated using the USNA 14 MeV neutron generator. The response was measured at several distances in order to separate direct from scattered radiation effects.

Data analysis is counting with result expected to be produced this summer. Project is in collaboration with Dr. G. Riel, Naval Surface Warfare Center, White Oak, Maryland.

## **Water Capture and Treatment System for the Automated Hull Maintenance Vehicle**

Researcher: Professor M. L. Nuckols  
Sponsor: Naval Surface Warfare Center, Carderock Division, Annapolis, Maryland

The feasibility of integrating an effluent capture and water treatment system with an automated ship hull maintenance vehicle was investigated. This investigation included, first, a review of potential capture and treatment concepts to be used with the hull maintenance vehicle; second, an analysis of the effluent copper concentrations and effluent flow rates. These data are critical parameters in the selection and design of water treatment facilities to handle hull cleaning discharge. The effects on effluent copper concentrations are evaluated over a wide range of effluent flow rates, ratios of dissolved copper in the effluent, paint thicknesses removed, fraction of hull surface cleaned, composition of the antifouling paint,

and rates of hull surface cleaning; third, a conceptual design of a discharge capture system which incorporates a submersible, centrifugal pump with the hull cleaning vehicle to deliver the discharge to the surface for treatment; fourth, an analysis of the pumping requirements to deliver the vehicle discharge to the surface. This analysis evaluates the effects on pump power requirements over a wide range of discharge flow rates, pipe diameters, pipe lengths, pumping efficiencies, discharge heights above sea level and vehicle depths; fifth, a review of potential water treatment options including a discussion of wastewater treatment technology.

## **Certification of the National Undersea Research Center at the University of North Carolina-Wilmington**

Researcher: Professor M. L. Nuckols

Sponsor: National Oceanic and Atmospheric Administration,  
Office of Oceanic Research

A review of the programs at the National Undersea Research Center at the University of North Carolina, Wilmington, was conducted to ensure that they are responsive to the United States' most important needs for undersea research and that they are managed for

maximum effectiveness and productivity. This review was conducted with a panel of researchers from around the United States for program certification for the next 6 years.

## **Reliability Centered Maintenance**

Researcher: Kenneth L. Tuttle, Associate Professor

Sponsor: Naval Sea Systems Command, Surface Ship Maintenance Office

The purpose of this ongoing research is to develop a Maintenance Engineering Laboratory at the USNA for instruction of the Midshipmen in modern maintenance engineering concepts. Its objectives are: to develop instructional capabilities in maintenance engineering, to introduce Naval Officers to Reliability Centered Maintenance, and to conduct long range planning for introducing maintenance engineering into the curriculum.

The Maintenance Engineering Laboratory portion of the Diesel Engine-Room Laboratory has been upgraded to Integrated Condition Assessment System (ICAS). The ICAS components and hardware include a computer workstation, ICAS software, OPTO22 electronic data acquisition devices for slow speed A/D conversion at 1Hz and an IDAX100 high speed data logger and A/D converter operating at 50kHz for vibrations and cylinder firing pressures analyses. Recent upgrades allow operation of the ICAS System on the GM 3-71 Diesel Engine/Generator Set using a Personal Computer. The IDAX 100 computer which controls data acquisition, monitors alarm conditions, makes log sheets, maintains trend analyses and offers

some expert system capability, has a unique operating system which makes communication difficult. The new PC Interface has improved this communication and made a dramatic improvement in the quality of the instruction being given the midshipmen in modern maintenance concepts. During the past six years, more than six thousand new naval officers or future naval officers have been introduced to the concepts of modern maintenance practices in this Maintenance Engineering Laboratory. This year, progress has been made toward the addition of significant new engine monitoring capabilities and instructional capabilities. A replacement head has been modified to allow measurement of cylinder firing pressures. The USNA has joined the local developer of the ICAS system in developing further Diesel engine monitoring and analysis technology for the U.S. Navy including the addition of vibrations analysis equipment and the long range planning for Trident Scholar research support. In addition, a slide show presentation has been developed to better instruct the midshipmen in modern maintenance concepts such as Reliability Centered Maintenance.

## **Internal Wave Generation by Sea Ice in the Marginal Ice Zone**

Researcher: Jennifer K. Waters

Sponsor: Office of Naval Research through Stevens Institute of Technology  
(Ph.D. degree program)

Internal wave generation has been shown to be a primary contributor to the ice-water drag coefficient of sea ice moving in sharply stratified water, such as is found in the Marginal Ice Zone during the spring melt season. This study examines the effect of internal wave generation on the ice-water drag of ice floes moving in stratified water through analytical methods in

conjunction with further analysis of existing experimental data from model tests performed at Davidson Laboratory. Two different analytical methods are used, one is an analytical solution to the problem of a moving body, modeled as a system of sources moving over two-layer, stratified water, obtained with the use of Green's functions. The second

method is an adaptation of a quasi-analytical larger-scale ice movement model. Each model is shown to provide reasonable to good correlation with the experimental data. A discussion of the impact of this study on present and future ice floe numerical models

is discussed. The errors resulting from non-inclusion of internal wave effects is shown to severely hinder the predictions of ice floe free drift in the Marginal Ice Zone.

## **Bending and Compression Failure of Marine FRP Panels**

Researchers: Professors Gregory J. White and Thomas W. Butler  
Sponsor: Johns Hopkins Applied Physics Laboratory

The USNA Ship Structures Laboratory will conduct three series of structural test on FRP panels provided by Applied Physics Laboratory (APL). Each series will consist of nine panels; three solid laminate panels, three sandwich panels, and three hat-stiffened panels. The panels will be tested, according to the plan outlined below, in the Grillage Test Fixture at the U.S. Naval Academy Ship Structures Laboratory.

The First test series included nine FRP panels will be tested to destruction under in-plane compression only. The boundary conditions for the loaded edges will be specified by APL prior to each test.

The second test series included nine FRP panels tested under uniform lateral pressure to measure the load at which defections exceed the width/200. APL will again specify the boundary conditions for the loaded edges for each test.

The third test series used the same panels as in test series 2, test to destruction under a combination of in-plane compression and uniform lateral pressure. The boundary conditions will be determined by APL. The magnitude of the lateral pressure for each test will be decided by APL in consultation with Drs. Butler and White.

## **An Experimental Investigation into the Structural Stability of Tee-Stiffened Panels Under Combined Loads**

Researcher: Professor Gregory J. White and Assistant Professor Sarah E. Mouring  
Sponsor: Naval Surface Warfare Center, Carderock Division

This is the second part of a three part project involving the design, testing, evaluation, and reporting of a series of large scale structural tests on tee-stiffened panels. The experiments are being conducted using the grillage test fixture in the USNA Ship Structures Laboratory.

A non-linear finite element model (FEM) of the panels tested in the laboratory was developed. The FEM program ABACUS was used to attempt to model the collapse mechanism and to predict the collapse load.

# **Independent Research**

## **An Evaluation of the SAIC RADSTAR Dosimetry System**

Researcher: Lieutenant Edward B. Cashman and Professor Martin E. Nelson

The purpose of this research is to evaluate the SAIC RADSTAR personnel dosimetry system in terms of accuracy, linearity of response, and functionality of its telemetry system. Dosimetry for four different photon energies provided by the SAIC RADSTAR was compared with corresponding dosimetry from two established monitoring methods: the thermoluminescent dosimeter (TLD) and the self-reading pocket in chamber (SRPD).

The dosimetry provided by the SAIC RADSTAR

system proved as accurate and reliable as the data from the TLDs and the SRPDs over most photon energies studied. These studies showed that the energy compensated G-M tube in the RADSTAR system's PDE-4 dosimeter under responded by about 75% at an effective photon energy of 38 keV, while the uncompensated G-M tube in the RADSTAR system's extremity probe (EXT-1) over responded by 650% at an effective photon energy of 120 keV. Neither of these results were unexpected, and both agree well with the

manufacturer's performance information.

A Co-60 source was used to determine the linearity of the response of the PDE-4 and the EST-1. Both responded nearly linearly with incremental radiation exposure up to 185mR. The exposure rate information reported by the PDE-4 also proved to be accurate to within 10% of the actual dose rate in almost all cases.

The telemetry system proved unable to penetrate any significant shield structures, but appears flexible

and reliable enough to be used in most radiation area applications. The signal has the ability to be reflected (once) and read by the base station, and to penetrate simple, non-shielded structures. The addition of repeaters, not tested here, would appear to overcome the telemetry system's shortcomings.

Because of a favorable evaluation, a proposal has been forwarded to Naval Reactors to have the SAIC RADSTAR System tested in a shipyard or onboard a nuclear powered ship/submarine.

## **Development of the USNA System for Neutron Activation Analysis**

Researchers: Ensign Michael R. Cooper, USN and Professor Martin E. Nelson

The purpose of the research was to develop the United States Naval Academy (USNA) system for Neutron Activation Analysis (NAA) into a user-friendly system. The USNA system is unique in that the activating source provides 14 MeV neutrons. These high energy neutrons are the result of a deuterium-tritium interaction created by the USNA neutron generator. Activated samples are counted by a high purity germanium detector, which is linked with a VAX computer system containing neutron activation analysis software. The project centers on the activation of nineteen known

elemental samples.

After gaining an understanding of the theory behind NAA and the knowledge of the hardware and software of the USNA system, Ensign Cooper modified the system into one that was user-friendly. As a result, a user can now take an unknown sample, activate it using the 14 MeV source, and identify its composition with a few simple steps. This improved system is now used in EN463 and used by midshipmen in independent research.

## **Machine Monitoring and On-Machine Acceptance Criteria through Acoustic Emission**

Researcher: Lieutenant Junior Grade Beth L. Pruitt, USN

This is an ongoing research project which is investigating current acoustic emission techniques, applications, and algorithms developed to monitor machining processes and provide real-time feedback. Experiments are in progress with various tools (e.g.,

High Speed Steel and Carbide tip) and work piece materials to determine a repeatable monitoring technique. The purpose of this research is to develop a design for an on-machine monitoring system.

## **Pollution from Ship Stack Emissions**

Researcher: Associate Professor Kenneth L. Tuttle

The purpose of this research is to determine whether stack emission from ships should be regulated and what technology would effectively reduce stack emissions from marine power plants. Written input has been submitted to the EPA in an attempt to convince the U.S. that ship exhaust emissions especially U.S. Navy ships should not be regulated as they burn low sulfur fuel already and most have engines that produce low oxides of nitrogen. All ship engines are inherently clean burning. The EPA has submitted the paper and letter to the Air Docket A-92-28 for use in finalizing EPA's marine engine regulation. This research surveyed available emissions data and showed that stack

emissions from marine power plants do not contribute substantially to air pollution nor water pollution. Additionally, it showed that estimates being used by the EPA to decide whether to regulate these sources are inflated and that regulation is not warranted. The results of this research have been presented to the Society of Naval Architects and Marine Engineers (SNAME), Great Lakes Section, and have been submitted for publication in Marine Technology, a peer reviewed journal, and to SNAME for inclusion in a book titled, Ship Design and Operation in Harmony with the Environment.

## **Shipboard Pollution Control Study of the Naval Studies Board, National Research Council**

Researcher: Associate Professor Kenneth L. Tuttle

The researcher has been appointed to the Naval Studies Board of the National Research Council's Commission on Physical Sciences, Mathematics and Applications, because of his unique expertise and experience in burning solid wastes. The Navy has requested the Navy Studies Board to find answers to the following questions: what shipboard technologies or procedures will be needed to eliminate non-food waste discharge from Navy ships? What is the status of these technologies and what additional development and testing is required? What is the technical feasibility of eliminating these discharges by the year 2000 for surface ships and 2008 for submarines operating in Special Areas? What is the time frame for completing development and beginning shipboard installation of the new technologies? What is the feasibility of back fitting existing ships versus forward fitting new construction ships? What would be the total cost to develop, purchase, and install the new technologies?

Recognizing that environmental restriction on Navy ships and submarines may increase with time, what additional technologies and practices hold promise of ultimately permitting Navy ships to be discharge-free during the course of an average cruise? The purpose of the present research is to answer these questions.

Over the past year this researcher has been investigating the possibility of incineration to destroy shipboard trash rather than dumping at sea. There is great support for burning to destroy shipboard combustible wastes, that is, outside of various environmental groups. However, the Environmental Protection Agency may have reached a consensus that combustion of solid wastes is the most ecologically sound option. There has been great pressure to force the Navy to burn its wastes since a 1993 ruling. This research will help the Navy decide whether to burn it and what equipment to use.

## **Research Course Projects**

### **Evaluation of Temperature Compensated Bubble Dosimeters for Treaty Verification Applications**

Researcher: Midshipman 1/C Bradford W. Baker, USN

Advisers: Assistant Professor Mark J. Harper and  
Professor Martin E. Nelson

Sponsor: Defense Nuclear Agency

Due to its small size, lack of electronics, and non-obstructive data collection capability, the bubble dosimeter is a possible instrument to be used in distinguishing between nuclear and non-nuclear munitions. The purpose of this research is to investigate the response of alternate droplet material bubble dosimeters as it pertains to arms control verification procedures. This is a theoretical and

experimental study of the bubble dosimeter's response to warhead neutron intensity and energy, gamma radiation, temperature and neutron energy. Conclusions are drawn regarding the potential use of bubble dosimeters for treaty verification applications. Through research on simulated warhead sources, practical procedures are outlined for using the bubble dosimeter to distinguish nuclear from non-nuclear munitions.

### **An Experimental Study of Wave Energy Attenuation due to Stiff Artificial Reeds**

Researcher: Midshipman 1/C Bruce J. Donald

Adviser: Assistant Professor Sarah Mouring

The objective of this research was to study the effects of stiff artificial reeds on wave energy transmission,

reflection, and dissipation. Similar reeds could be used for shore protection if they exhibit desirable



characteristics. The effects of the reeds were investigated by running a series of different waves through a two foot square test array consisting of rigid reeds. Both a full pattern of 529 reeds and a staggered pattern were found to transmit 30-70% of the wave energy. Reflection tests showed minimal amounts of wave energy being reflected by the test structure (<10%). Interestingly, different properties of the waves tested significantly effected the amount of energy transmission and attenuation. Several nondimensional analyses were performed using wave steepness, Keulegan-Carpenter number, Reynolds number, and other various dimensions. Larger wave steepness

causes a reduction in the transmission coefficient and an increase in the percentage of energy dissipation within the structure. Higher particle velocities and therefore increased flow properties such as vortex shedding and flow interference caused by the reed array account for the decreased energy transmission. These findings hold great promise for the use of reed array type structures as shore protection means. Greater wave steepness usually is associated with larger, more damaging waves. In addition, use of reeds still allows water and sediment transport and may provide an environment habitat for many different aquatic species. The project has been completed except for paper submittal.

## **Computer-Aided Milling and Open Water Testing of Low Power, Low RPM, Large Diameter Propellers**

Researcher: Midshipman 1/C D. Gavin Duff, USN

Adviser: Professor Roger H. Compton

The low power, low RPM, large diameter propeller designed by Schmidt & Smullen in 1992 was digitized and converted into an acceptable format for computer-aided milling in the Technical Support Department. A hub was designed and fabricated to allow several pitches to be set for the two blades. A new nosecone was designed and fabricated for the Hydromechanics Laboratory's propeller boat. After static balancing and

blade pitch setting were accomplished, open water propeller tests were conducted in the 380 foot towing tank at three pitch settings.

As designed, the propeller comes close, but does not quite satisfy the design thrust output for the torque required. It does however, form a solid benchmark for future design iterations.

## **Dispositioning of Excess Plutonium**

Midshipman 1/C Joong S. Ko, USN

Adviser: Assistant Professor Mark J. Harper

One outcome of the Cold War between the United States and the former Soviet Union is the stock piling of nuclear weapons. The Cold War is over, and under the Strategic Arms Reduction Treaties (START I & II), many of those nuclear arms are being dismantled. That leaves the problem of dispositioning of the excess plutonium from dismantled nuclear arms. One of the principal dispositioning options is to burn the plutonium by utilizing a mixture of uranium and plutonium (mixed-oxide or MOX) fuel in nuclear reactors. This MOX fuel is not a new concept to the nuclear industry. There are many countries which

operate their nuclear reactors using this fuel.

The purpose of this research was to determine how much weapons grade plutonium can be used in a MOX fuel and how much non-weapons grade plutonium will be produced. Allen Croff of Oak Ridge National Laboratory developed the computer code ORIGEN to calculate the buildup, decay, and processing of radioactive materials. This code was used to study the various MOX fuel options and to determine the amount of plutonium present in the initial and spent fuel. The study used various types of reactors: pressure, water, boiling water, and Canadian deuterium.

## **The Model Testing of Planing Hulls: Effects of Experimental Methods**

Researcher: Midshipman 1/C Richard B. Lawson

Adviser: Professor Roger H. Compton

Towed model testing of planing hulls requires that special attention be paid to those hydrodynamic factors which characterize the planing phenomenon. These

include: speed dependent characteristic flow lengths and wetted surfaces, relationship of thrust vector to hull-location and direction, separation of the flow at the

transom (Kutta Condition), separation of the flow along chines (or spray strips), interdependence of resistance and running trim, angle over speed range, and aerodynamic drag of the hull at high speeds.

Additionally, turbulence stimulation on a small model must be addressed differently due to trim and lift. A series of carefully controlled model tests of a minimal 40 foot long, 40,000 pound, hard chine planing boat was designed and performed to address these issues. The major findings were, the detailed geometry of artificial devices to ensure flow separation at the model transom (e.g., mylar strips) has a major

effect on both resistance and running trim angle, at high speeds, the aerodynamic drag of the model under the carriage is measurable and should be taken into account, turbulence stimulation by artificial means is rendered less significant due to high velocities, calculation and application of an unloading force on a free-to-trim, free-to-rise model is a viable experimental technique, and measurement of wetted lengths and the resulting calculated characteristic length and wetted surface at each speed is a necessary complicating for planing boat model testing.

## **The Design and Construction of a High Temperature Photon Emitter for a Thermophotovoltaic Generator.**

Researcher: Midn 1/C Robert S. McHenry

Advisers: Assistant Professor Mark J. Harper, Associate Professor Keith W. Lindler, and Professor Martin E. Nelson

Sponsor: Department of Energy

This research resulted in the engineering design of a high temperature photon emission core for a Thermophotovoltaic electrical generator. A comprehensive design approach included theoretical research, computer modeling, prototype experimentation, and final system design. The photon emitting surface is a 12 inch long, 4 inch diameter cylinder which produces a near blackbody photon spectrum centered at 0.7 eV.

The emitter is heated by methane combustion and can achieve temperatures in excess of 2700°F. Ceramic materials, including inexpensive ceramic mortars, are utilized for the majority of the system components. The design includes a simple recuperative heat exchanger to preheat combustion air and set point gas flow control to maintain steady state emitter temperatures.

## **Disposition of Plutonium**

Researcher: Midshipman 1/C Sean M. Muth, USN

Adviser: Assistant Professor Mark J. Harper

Under the Strategic Arms' Reduction Treaties, (START I and II), the United States will significantly reduce its nuclear weapons arsenal. There is great concern about what to do with the weapons grade plutonium in the warheads. The National Academy of Sciences wants to make the excess plutonium meet the spent fuel standard. The spent fuel standard is the standard where weapons usable plutonium is as inaccessible for weapons use as the plutonium in spent fuel from commercial reactors.

This research examined the several different possibilities of managing and disposing of the

plutonium. The current practice is to store the warheads at the Pantex facility in Texas. Other options include building a central facility, burying the plutonium, mixing the plutonium with existing high level waste, and reprocessing the plutonium to make mixed-oxide fuel for current reactors. The solution was evaluated based on resistance to theft, technical viability, environmental impact, safety, health considerations, cost effectiveness, timeliness, public acceptance, and the ability to foster cooperation with the former Soviet Union.

## **The Study of Augmentation Gas Injection into a Gas Turbine**

Researcher: Midshipman 1/C Michael R. Santini, USN

Adviser: Assistant Professor Martin R. Cerza

The goal of this investigation was to determine whether Helium, Argon, or Nitrogen injection into a gas turbine held any beneficial effects for naval applications of gas turbine technology. A stoichiometric analysis was performed to examine the theoretical results of adding the above mentioned gases into the intake manifold of a small auxiliary power unit gas turbine. Data was also experimentally collected from test runs of five different augmentation gas flow rates at five distinct power settings. The data was collected with a Superflow data acquisition unit coupled to the 80 BHP Garret Gas Turbine located in the Marine Propulsion Laboratory of the United States Naval Academy. Also investigated was the relationship between air to fuel ratio and the

adiabatic flame temperature. From the collection of theoretical and experimental data, it can be shown that the injection of augmentation gases into the gas turbine has an increased effect on fuel economy for a constant load settling. It is inconclusive, however, as to whether this fuel savings is due to the presence of the augmentation gases in the combustion gases, thereby, modifying the combustion gases to exhibit a more ideal behavior, or if the fuel savings is solely due to an optimized air fuel ratio. Recommendations are made for future experiments that might provide more conclusive results. An investigation into theoretical gas mixing theory is also underway, funded separately by Office of Naval Research (ONR).

## **Irradiation of Electronic Packaging Materials with 74 MeV Neutrons**

Researcher: Midshipman 1/C James D. Shell and Midshipman 1/C Dennis W. Klein

Adviser: Professor Martin E. Nelson

This experiment searched for the mechanisms of hard failure on a multi-layer computer board from a major unnamed vendor. Selected areas on the board were sliced into wafers with a diamond saw, scanned by Near Infrared Spectroscopy and examined in a Scanning Electron Microscope. The wafers were irradiated with varying doses of 14.3 MeV neutrons. Activated samples were read by a Germanium type gamma detector. The samples were again scanned by Near Infrared Spectroscopy and examined in an Environmental Scanning Electron Microscope.

The purpose of our research was to better

understand these mechanisms and the analysis of them. Our analysis searched for five radiation induced parameters; oxidation of interlaminar and laminate polymer, cross-linking of the interlaminar and laminate polymer, physical defects, metal migration and magnesium formation in the glass fibers of the reinforced laminate matrix.

Our experiment found inconclusive evidence to correlate any of the above effects to the induced radiation, with the exception of magnesium formation. Recommendations are given to more effectively allow further research to continue in this field.

## **An Analysis into the Uncertainty of Stiffened Panel Ultimate Strength**

Researcher: Midshipman 1/C Robert H. Vroman, USN

Advisers: Professor Gregory J. White and Assistant Professor Sarah E. Mouring

Sponsor: Naval Surface Warfare Center, Carderock Division

The objective of this project is to determine the level of uncertainty associated with the ultimate strength predictions generated by the analytical algorithm used in the design of stiffened panels for ships.

This investigation into the modes of ultimate failure of stiffened panels is divided into three approaches: experimental tests of grillages in the USNA Ship Structures Laboratory, analysis of historical stiffened panel test data found in the literature, and non-linear finite element analysis. By comparing the predicted failure stress and deflections

between the various methods, the level and areas of uncertainty can be recognized and quantified.

Three tests were conducted in the USNA Ship Structures Laboratory. The data from these tests were compared to the historical tests found in the literature. A statistical data analysis was conducted to determine the most important factors influencing the modeling bias associated with stiffened panel ultimate strength.

The non-linear finite element analysis of the USNA grillage was able to model the buckling of the panel, but could not solve for the post-buckling behavior. Further

experimental tests and finite element models need to be tested in order to confirm the validity of some of the

predicted values and the overall reliability of the method.

## Adaptive Control Retrofit for Machine Tools

Researcher: Midn 2/C Richard W. Whitlock, USN

Faculty Advisers: Associate Professor Kenneth L. Tuttle and Thomas E. Calvert, NSWC

Sponsor: Naval Surface Warfare Center, Annapolis, Maryland

This project will improve the user interface of a low cost adaptive control retrofit for machine tools. During the manufacturing process of complex surfaces it is necessary to vary the cutting tool feed rate. A fuzzy logic controller using vibration sensors can optimize the feed rate much more precisely than a trained human operator. However, it is necessary for the operator to interface with the controller to optimize the parameters

and guidelines the controller uses to run the machine. A user-friendly interface will allow the operator to maximize the use of the controller and thereby realize the advantage of computer control. The student's part of the project was to write the code using C++ including the graphic display part and the mill control function to be used.

## Publications

BAKER, Bradford W., Ensign, USN, Mark J. HARPER, Assistant Professor, and Martin E. NELSON, Professor, "Evaluation of Temperature Compensated Bubble Dosimeters for Treaty Verification," Technical Report, Defense Nuclear Agency, September 1994.

Due to its small size, lack of electronics, and non-obstructive data collection capability, the bubble dosimeter is a possible instrument to be used in distinguishing between nuclear and non-nuclear munitions. This report presents an investigation into the response of alternate droplet material bubble dosimeters as it pertains to arms control verification procedures. This is a theoretical and experimental study of the bubble dosimeter's response to warhead neutron intensity and energy, gamma radiation, temperature and neutron energy.

HARPER, Mark J., Assistant Professor, Martin E. NELSON, Professor, and Andrew D. BUCKON, Lieutenant, USN, "Air Classification Method at the Nevada Test Site," Radwaste, 1, October 1994, 28-32.

The Naval Academy research group has demonstrated in their laboratory-scale testing, using bismuth as a surrogate for plutonium contamination, that significant volume reduction can be achieved. It remains to be seen, however, whether their two-step air classification/sieving process will achieve similar results during bench-scale testing using soil contaminated with plutonium and uranium from several DOE sites around the country. These tests were

conducted by the University of Nevada-Reno in August of 1994 as part of the expanded Integrated Demonstration for Plutonium in Soils. A follow-up report on the results will be published in RADWASTE magazine when they are available.

The anticipated volume reduction of the Naval Academy method looks promising. Further refinements to the system include an increase in the rotor speed, which appears to affect the denser particles more than any other variable, and the incorporation of triboelectrification into the air classification part of the process.

HARPER, Mark J., Assistant Professor, Martin E. NELSON, Professor, and Andrew D. BUCKON, Lieutenant, USN, "Air Separation of Heavy Metal Contaminants from Soil," 124th TMS Annual Meeting, Las Vegas, Nevada, February, 1995.

Several heavy metal separation techniques are currently being developed for soil remediation at various Department of Defense and Department of Energy (DOE) Facilities. The majority of these techniques involve a wet process using water, PH modifiers or other compounds. The United States Naval Academy (USNA) has developed a dry process for heavy metal separation. The process uses air classification technology to concentrate the metal contaminant into a fraction of the soil. The advantages of this dry process are that it creates no contaminated byproduct and uses commercially available technology.

The USNA process is based on using Gayco-Reliance air classifier. Tests have been conducted with

the system at the Naval Academy and the University of Nevada-Reno (UNR). The USNA tests used soil from the Nevada Test Site mixed with bismuth at a concentration of 500-1000ppm. The UNR tests used soil from four DOE sites mixed with uranium oxides and plutonium at an activity level of 100-700 pCi per gram. Concentration of activities and volume reduction percentages are presented for the various soils and contaminants tested.

HARPER, Mark J., Assistant Professor, ENS Bradford W. BAKER, and Professor Martin E. NELSON, "Investigation of Alternate Droplet Material Bubble Dosimeters," *Health Physics*, 6, (May 1995), 670-673.

Past theoretical research involving superheated liquid droplet (bubble) neutron dosimeters has shown the possibility of using alternate droplet materials in order to give the dosimeter improved temperature stability. Based on that research testing was conducted on HFC-134a, propylene, propane, and hexafluoropropylene to determine (1) the compatibility of the novel superheated liquid material with the detector gel matrix material; (2) the gamma sensitivity of the detector droplets; (3) the response of the dosimeters as a function of neutron energy; and (4) the response of the dosimeters as a function of temperature. These tests were conducted at the Armed Forces Radiobiology Research Institute using a  $^{60}\text{Co}$  source, the Naval Surface Warfare Center using a tandem neutron accelerator, and the United States Naval Academy using an unmoderated  $^{252}\text{Cf}$  source. The response of the alternate droplet material dosimeters was compared to the response of the original Freon 12 droplet material dosimeter. The data indicated that the propane and propylene materials were chemically incompatible with the gel material and that the hexafluoropropylene dosimeters were sensitive to gamma radiation, this making these types of dosimeters unsuitable. However, the HFC-134a superheated liquid droplets were stable in the gel material, responded uniformly over varying neutron energies, and had a predictable temperature response.

HAWLEY, J. Gary, LCDR, RN, Peter F. WIGGINS, Professor, and Pierre G. VINING, Captain, USN, "Thermodynamics of Marine Engineering Systems," Kendall/Hunt Publishing Company, Iowa, USA, August 1995.

After developing some basic principles of thermodynamics, this book uses a building block approach, beginning with relatively straightforward ideal systems and sequentially refining the analytical tools needed to comprehend and evaluate ever more realistic installations. Rather than initially presenting all concepts needed to analyze any thermodynamic system, new concepts, properties, laws and definitions

are introduced throughout the text when needed to explore the next level of "reality" in the category of systems being examined. In this way, practical understanding is emphasized, and the book attempts to bridge the gap between the underlying theoretical principles and their useful application, specifically in marine systems. Example problems are used throughout to illustrate real world considerations surrounding performance, efficiency and economy. Comparative case studies are used extensively to highlight the "value added" of successive design enhancements.

JOHNSON, Bruce, Professor, "Engineering Economic Analysis," 5th Edition, Engineering Press, San Jose, California, 1994.

and

JOHNSON, Bruce, Professor, "The Use of Windows-Based Spreadsheets to Teach Engineering Economics Concepts," Paper # 1639, ASEE Annual Conference Proceedings, June 1995.

This paper demonstrates the advantage of a general purpose approach to spreadsheet development using standard analysis tools for making economic choices among multiple alternatives. Ratio-based sensitivity and breakeven analyses in spreadsheet formats allow engineering students to gain insight into before- and after-tax cash flow analysis of real-world financial problems. Such "what-if" analysis of complex problems is too time consuming to be practical using a calculator and compound interest tables.

Several spreadsheets are presented and are available in diskette form from the author. For performing before tax cash flow analysis, SALTEL allows one to compare up to five ALTERNATIVES with Equal Lives by calculating net present worths, annual worths, benefit/cost ratios and incremental rates of return simultaneously. 3ALTUL compares up to three ALTERNATIVES with Unequal Lives for an analysis period equal to the least common multiple of their useful lives or a common termination year.

The standard tabular format for solving after-tax cash flows is incorporated in the spreadsheet ATAXNL, which handles the purchase of business assets using full equity financing (no loan or leveraging). ATAXFIN allows one to evaluate the merits of various standard methods of leveraging asset purchases using "other people's money." ATAX4ALT allows one to compare up to four equal life alternatives on an after-tax cash flow basis with maximum flexibility in the input data for each alternative.

JOHNSON, Bruce, Professor, and Robert H. MAYER, Associate Professor, "On the Use of Windows-based

Spreadsheets in Teaching Wave Mechanics and Design Project Decision Support Concepts to Ocean Engineering Students," Paper #3478, ASEE Conference Proceedings, Vol II, June 1995, 1681-1685.

This paper discusses the development of several general-purpose spreadsheets which allow the student to perform "what-if" analyses of typical ocean engineering problems. Open-ended problems are quite tedious when using a calculator to analyze information presented as tabular data. Windows-based multi-page spreadsheets enable computer-literate students to learn a single programming methodology to satisfy the analysis requirements for most upper level engineering courses. Typical spreadsheet homework assignments in the wave mechanics courses at USNA include coding and plotting linear wave characteristics and constructing laboratory data analysis modules. In support of design projects, structural analysis, economic and risk analysis modules are developed to enhance engineering decision making. Design progress reviews are also presented as "slide shows" using Quattro Pro 6.0 for Windows. Sample spreadsheets and graphical outputs are provided to illustrate these applications.

KRIEBEL, David L., Associate Professor, and Thomas H. DAWSON, Professor, "Evolution of Wave Breaking in Random Seas," Proceedings International Symposium: Waves - Physical and Numerical Modelling, Vol II, pp 763-772, Vancouver, British Columbia, 1994.

The evolution of breaking waves within wave groups is considered for a laboratory-generated deep-water random sea. The study was motivated by observations that spatial and temporal characteristics of breaking waves are related to the fact that individual waves propagate faster than wave groups. Measurements of the water surface generated from a Joint North Sea Wave Project (JONSWAP) spectrum were obtained at 13 spatial locations over a 12.2 meter-long region in the USNA large wave tank. From this data, space-time characteristics of wave breaking are determined, including the persistence (duration) of breaking events and the separation (interval) between breaking events. Details of the spatial and temporal growth and decay of individual breaking waves are also documented.

LINDLER, Keith W., Associate Professor, "Theoretical Analysis of Air Classifiers to Remove Heavy Metals from Soil," Proceedings of the 29th Intersociety Energy Conversion Engineering Conference, Monterey, California, August 1994, 1163-1167.

Extensive nuclear testing that has been conducted at the

Nevada Test Site, other Department of Energy (DOE) sites, and many Naval Facilities Command (NAFAC) sites has left heavy metal radioactive contaminants such as Plutonium in the soil. Environmental restoration efforts have been initiated to purify the contaminated areas. The current effort by DOE involves many different approaches including physical, chemical and biological separation. This paper presents a theoretical analysis of the potential of air classifiers used to remove heavy metals from soil. Spreadsheet calculations indicate that air classifiers in conjunction with sieves can theoretically exceed the project goal which is to remove 80% or more of the plutonium with 20% or less (by volume) of the soil.

MAYER, Robert H., Associate Professor, and David L. KRIEBEL, Associate Professor, "Wave Runup on Composite-Slope and Concave Beaches," Proceedings of the 24th International Conference on Coastal Engineering, ASCE, November 1994, 2325-2339.

Laboratory experiments were carried out for regular and irregular wave runup over non-uniform beach profiles, including both bi-linear and concave "equilibrium" beach profiles. Measured runup is shown to be substantially less than that predicted by the Hunt formula, if the exposed beach face is used to define the beach slope. More accurate runup estimates are obtained using Saville's hypothetical slope concept, and Saville's method is integrated with the Hunt formula to provide simple analytic estimates of wave runup over complex beach topography.

MCCORMICK, Michael E., Professor and Sarah E. MOURING, Assistant Professor, "An Experimental Study of the Damped Planar Motions of Towed Ships," Symposium Proceedings: Marine Technology Society, MTS'94, September 1994, 2-3-2.

The influence of the currents on single point moored (SPM) ships can cause low frequency fish-tailing motions. These motions can cause large tensions in the mooring lines. In the past, moorings have failed when the forces applied exceeded the snap load. Currently, there is no method to determine accurately ship motions and the associated snap load of a ship moored in a current.

The purpose of the study was to determine the neutrally-stable current speed, beyond which, the motions of the ship become unstable. A FFG-7 model was towed at speed corresponding to prototype speeds of one, two, three, four, and five knots. The model was connected to the towing carriage by aluminum rods of two, three, and four feet in length. Measurements of the angle between the rod and the carriage, and the rod and the centerline of the ship were made by two

potentiometers. These measurements were analyzed to determine the sway as a function of time in a dimensionless form. Results were analyzed assuming linear damping and presented for different hawser lengths. For a given towing speed, it was determined that there is a specific hawser length for which the motions are neutrally stable.

MCCORMICK, Michael E., Professor, and Sarah E. MOURING, Assistant Professor, "On the Nonlinear Motions of Moored Ships," USNA Report EW-5-94, June 1994.

The purpose of this report is to examine in detail the effects of the nonlinear terms of the planar equations of motion of single point moored (SPM) ship. These ships are subjected to winds, waves, and currents. Previously, the hydrodynamic equations of motion were developed by de Kat and Wichers neglecting many nonlinear terms. In order to investigate this simplifying assumption, a study into the sensitivity of ship motion to neglected higher order nonlinear terms is made.

The nonlinear equations of motion were developed by Professor Michael E. McCormick and Assistant Professor Sarah Moring, where all of the nonlinear terms were included. These modified equation have been simultaneously solved by developing a computer program using the computer language, Advanced Continuous Simulation Language (ACSL). The equations of motion were applied to both combatant and commercial ships using the computer program. Results show that there is a great level of sensitivity of the nonlinear motions to each neglected higher order term. Therefore, these higher order terms should not be neglected in the nonlinear analysis of ship motions.

MCCORMICK, Michael E., Professor and Sarah E. MOURING, Assistant Professor, "A Theoretical Analysis of the Planar Motions of a Single Point Moored Ship in a Steady Current," Symposium Proceedings: Marine Technology Society, MTS'94, September 1994, Paper 1-10-1.

A theoretical analysis of the nonlinear planar motions of a single point moored ship is presented. The predicted motions of the ship can be wither stable or unstable when in a current. When stable, the ship responds in a fashion similar to that of a fluttering wing. That is, the amplitudes of the planar motions increase in time, while the frequencies of the motions decrease. The analysis is applied to a fast frigate (FFG) moored in a current 1.0 mps (about 2 knots). For this current, the motions are unstable, their oscillations limited by the inflexible hawser attached to the bow. Higher-order inertial terms. neglected in the analyses of

supertankers, are found to produce effects on the ship motions and the resulting tension in the hawser early in the time-histories of the motions. The analysis can be used to determine if the current-induced motions of the ship will result in hawser tensions that exceed the snap load.

MCKENNEY, Timothy L., Lieutenant, USN, "Feasibility of a Ship Scrapping Yard in Philadelphia," Journal of Ship Production, Vol 10, No. 3, August 1994, 191-201.

This paper examines the feasibility of establishing a ship scrapping facility on the present site of Philadelphia Naval Shipyard. Potential ship disposal markets and the current state of the shipbreaking industry are examined. Current methods are reviewed and a new method incorporating emerging technologies is proposed. Five critical financial drivers that impact the viability of domestic scrapping firms are examined. On the basis of this background, two options are proposed for establishing a scrapping facility.

MCKENNEY, Timothy L., Lieutenant, USN, "Environmentally Safe and Economically Sound Method of Ship Scrapping," SNAME Transactions, Vol. 102, 1995, 141-152.

This paper examines domestic ship scrapping with a view toward improvement. The current state of the ship breaking industry and the environmental issues that affect it are reviewed. Two proposals are made. The first is a method of disassembling ships in an environmentally safe and economically sound manner that is enabled by an emerging cutting technology. The second is a proposed method of obtaining more value from the products of ship scrapping. It is determined that some U.S. government involvement is required to assure the economical and environmentally sound disposal of its ships.

NEHRLING, Bruce C., Professor and Roger H. COMPTON, Professor, co-author, "Some Observations on Experimental Techniques for Modeling Ship Stability in Wind and Waves," Proceedings of the Fifth International Conference on Stability of Ships and Ocean Vehicles (STAB '94), Melbourne, Florida, November 1994.

A series of experiments for measuring the intact and damaged stability characteristics of scale ship models in wind and waves have recently been conducted at the United States Naval Academy's Hydromechanics Laboratory. This paper describes the equipment developed for these experiments, discuss the various modeling techniques investigated, and presents some

general conclusions and observations. The generation, measurement, and behavior of the wind field is a key element in the success of these experiments. Sets of centrifugal fans, spanning the width of the Academy's larger towing tank, generated the wind field for each run and electro-mechanical anemometers mapped it. The behavior of a wind field in an enclosed towing tank places special requirements on the size and position of the ship model, its restraint system and the subsequent analysis of the acquired data. Model tethering considerations are addressed. The influence of simplified 2D superstructure versus a more realistic but costly 3D superstructure is discussed.

Experiences gained with the use of non-intrusive system to video tape the model's motions and the subsequent computer analysis of this time history are described. The relative influence that wind only, waves only, and wind and waves have on a model's behavior are compared.

NEHRLING, Bruce C., Professor, and Roger H. COMPTON, Professor, co-author, "Intact Stability Criteria Revision Project (Part II); Model Test Validation of Sea Trial Performance of a U. S. Coast Guard 378' High Endurance Cutter: Zero Speed Pitch and Roll Motions in Wind and Waves; Pitch and Heave Motions in Head and Following Seas," Report #EW-07-94, July 1994.

An ongoing international effort to review, improve, and update ship stability criteria has employed physical scale modeling, analytical modeling, and full scale sea trials to understand and develop criteria which insure adequate safety over a ship's life. The U. S. Naval Academy Hydromechanics Laboratory (NAHL) has been involved in this criteria development process primarily in the performance of physical scale model experimentation in wind, waves, and combined wind and wave environments. Following full scale sea trials on the USCGC BOUTWELL, a HAMILTON class cutter, in the Gulf of Alaska during January of 1994, the NAHL conducted an experimental program intended to recreate, in the laboratory, selected conditions experienced at sea by the BOUTWELL. This paper presents results from simulating specific data runs from the sea trials in the 380 foot towing tank at NAHL. Three involved testing at zero forward speed in wind and wave conditions at various relative heading; three involved irregular wave testing at Froude scaled ship speeds in head and following sea conditions. Pitch, roll, and vertical acceleration data were acquired from the model in the zero speed wind and wave tests; pitch and heave data were acquired from the at-speed tests. Model data and full scale trial data are correlated and discussed.

NEHRLING, Bruce C., Professor and Roger H. COMPTON, Professor, "Intact Stability Criteria Revision Project (Part III); Model Testing U. S. Coast Guard Cutter's Roll Dynamics for FREDYN Development Efforts", Report #EW-08-94, August 1994.

An ongoing international effort to review, improve, and update ship stability criteria has employed physical scale modeling, analytical modeling, and full scale sea trials to understand and develop criteria which insure adequate safety over a ship's life. The U. S. Naval Academy Hydromechanics Laboratory (NAHL) has been involved in this criteria development process primarily in the performance of physical scale model experimental in wind, waves, and combined wind and wave environments since fundamental roll dynamics parameters such as natural periods, decay coefficients, and virtual inertia for ships are derived more easily from model test procedures than from full scale, at-sea testing, the purpose of these experiments are to assist the computer analysts who are developing FREDYN, a state-of-the-art, time domain ship motion and stability program. This paper describes several "simple" experiments conducted using a Hamilton class cutter model.

A number of salting experiments were conducted at zero speed to quantify the effects of the NAHL soft restraint system on roll motion dynamics, and the influence of various underwater appendages. Salting experiments over range of forward speeds were conducted to examine speed effects. Zero speed beam sea rolling in long crested, regular waves was performed for a variety of model loadings, wave steepness, and wave frequencies. Zero speed rolling in long crested irregular waves was done with and without beam winds to study the damping effect of wind.

NELSON, Martin E., Professor, Mark J. HARPER, Assistant Professor, Keith W. Lindler, Associate Professor, Ricardo Saez-Ortiz, LCDR, USN, Wayne D. Gunther, Ensign, USN, and Andrew D. Buckon, LT, USN, "Evaluation of Air Classification Technology for the Removal of Heavy Metals from the Soil," Division of Engineering and Weapons Report EW-14-95, January 1995.

Various activities, such as weapons or ordnance testing, have confronted U.S. Department of Energy and Department of Navy facilities with the challenge of removing heavy metals such as uranium, plutonium and lead from their site soil. While previous soil cleanup methods have indicated that physical separation of heavy metals from soil can be successful, more effective methods need to be developed. Among the physical separation technologies requiring further



study is the air classifier.

This paper presents a theoretical and experimental analysis of the applicability of air classification utilizing centrifugal and elutriation principles. This research was performed at the United States Naval Academy with specific experimentation on two commercially available mechanical separators. The first, a centrifugal air classifier, was obtained from the Sepor Corporation, and the second, an elutriation type separator supplied by the Ducon Company.

Air classification systems produce two effluent streams, which can be referred to as the fine and coarse fractions. Success can be achieved if the heavy metal can be concentrated in either stream. The initial project goal was to concentrate eighty percent of the heavy metal in twenty percent of the soil. Air classification of the heavy metal depends on the density difference between the soil and heavy metal as well the particle size distribution of the soil and heavy metals. This research optimized the two system's parameters using theoretical analysis and experimentation.

Results approaching the project goal were achieved by sieving the fine and coarse effluent streams. These results indicate that air classifier technology can be successfully employed in environmental restoration alone or as part of a multi-step process. Many options exist to manage air classifier effluents. Possible techniques include storing all or part of an effluent, returning all or part of an effluent to the environment, or utilizing further remediation technologies on all or part of an effluent. The exact procedure depends on the level of contamination present and the amount of concentration required in any given remediation case.

NUCKOLS, M. L., Professor, "Oxygen Levels in Closed-Circuit UBA's During Descent," *International Journal of Life Support & Biosphere Science*, Spring 1995.

Closed-circuit rebreathers recirculate the diver's respiratory gas through a scrubber to remove exhaled carbon dioxide. For systems used in deep diving applications, oxygen is mixed with a diluent gas to maintain a preset partial pressure of oxygen ( $PP_{O_2}$ ) which is within the physiologically acceptable limits for the diver. These systems accurately maintain the oxygen set point while the diver swims at constant depth. However, as a diver increases depth, the gas volume in his lungs and his underwater breathing apparatus (UBA) will be compressed. To avoid

damage, a diluent gas, a breathable mixture of oxygen in some inert component such as nitrogen or helium, must be supplied to the breathing circuit so as to maintain constant volume. Since the composition of this diluent will normally be different from the desired circuit breathing mixture, it is important that the addition of this diluent will not have harmful physiological effects on the diver. The effects of UBA circuit volume, diver descent rate, oxygen consumption rate, and diluent composition on the oxygen partial pressures within the breathing circuit during descent are investigated in this paper. Exposures to oxygen partial pressures in excess of 2.0 ATA are shown to be possible during dives when using closed-circuit UBA's with preset  $PP_{O_2}$  levels of 0.7 ATA. These elevated oxygen exposures are shown to diminish when a diver reaches depth, but could last in excess of 18 minutes during a dive to 200 feet of seawater.

NUCKOLS, M.L., Professor, "Water Capture and Treatment System for the Automated Hull Maintenance Vehicle," Division of Engineering and Weapons Technical Report EW-10-94, USNA, August, 1994.

The feasibility of integrating an effluent capture and water treatment system with an automated ship hull maintenance vehicle is investigated. This investigation included: a) A review of potential capture and treatment concepts to be used with the hull maintenance vehicle. b) An analysis of the effluent copper concentrations and effluent flow rates. These data are critical parameters in the selection and design of water treatment facilities to handle hull cleaning discharge. The effects on effluent copper concentrations are evaluated over a wide range of effluent flow rates, ratios of dissolved copper in the effluent, paint thicknesses removed, fraction of hull surface cleaned, composition of the antifouling paint, and rates of hull surface cleaning. c) A conceptual design of a discharge capture system which incorporates a submersible, centrifugal pump with the hull cleaning vehicle to deliver the discharge to the surface for treatment. d) An analysis of the pumping requirements to deliver the vehicle discharge to the surface. This analysis evaluates the effects on pump power requirements over a wide range of discharge flow rates, pipe diameters, pipe lengths, pumping efficiencies, discharge heights above sealevel and vehicle depths. e) A review of potential water treatment options including a discussion of wastewater treatment technology.

## Presentations

BAKER, Bradford W., Ensign, USN, Mark J. Harper, Assistant Professor, and Martin E. Nelson, Professor, "Investigation of Alternate Droplet Bubble Dosimeters," Annual Meeting, Health Physics Society, San Francisco, California, June 1994.

CASSATA, James R., Lieutenant, USNR, "Total Quality Teaching," New Instructor Orientation, USNA, August 1994.

CERZA, Martin, Associate Professor, "Thermodynamic Mixing of Real Gases and Gas/Liquid Mixtures and the Effect on Enthalpy and Entropy," presentation to Dr F. Saalfeld, Head, Office of Naval Research, November, 1994.

COMPTON, Roger H., Professor and Bruce C. Nehrling, Professor, "Some Observations on Experimental Techniques for Modeling Ship Stability in Wind and Waves," Fifth International Conference on Stability of Ship and Ocean vehicles (STAB '94), Melbourne, Florida, 7-11 November 1994.

HARPER, Mark J., Assistant Professor, Martin E. Nelson, Professor, and Midn 1/C Robert S. MCHENRY, "A Proposed Alternate Cycle Power System," Knolls Atomic Power Laboratory, Schenectady, New York, February 1994.

HARPER, Mark J., Assistant Professor, Martin E. Nelson, Professor, and Andrew D. Buckon, Lieutenant, USN, "Soil Remediation Using Air Classification Technology," Annual Meeting, American Nuclear Society, New Orleans, LA, June 1995.

KRIEBEL, David L., Associate Professor, "Model Testing of a Deep Water Compliant Tower," Offshore Mechanics and Arctic Engineering Conference, Copenhagen, Denmark, June 1995.

KRIEBEL, David L., Associate Professor, "Wave Runup on Composite-Slope and Concave Beaches," Seminar, Department of Civil Engineering, University of Delaware, Newark, Delaware, 9 May 1995.

KRIEBEL, David L., Associate Professor, "Swash Zone Wave Characteristics from SUPERTANK," 24th International Conference on Coastal Engineering, Kobe Japan, 26 October 1994.

KRIEBEL, David L., Associate Professor, "Wave Runup on Composite-Slope and Concave Beaches,"

24th International Conference on Coastal Engineering, Kobe, Japan, 26 October 1994.

KRIEBEL, David L., Associate Professor, "Evolution of Wave Breaking in Random Seas," International Symposium on Waves - Physical and Numerical Modelling, Vancouver, BC, 22 August 1994.

LINDLER, Keith W., Associate Professor, "Theoretical Analysis of Air Classifiers to Remove Heavy Metals from Soil," 29th Intersociety Energy Conversion Engineering Conference, Monterey, California, August 1994.

LINDLER, Keith W., Associate Professor and Mark J. Harper, Assistant Professor, "Spreadsheet-based Computer Model of Gas-fired Thermophotovoltaic Energy Conversion Device," Knolls Atomic Power Laboratory (KAPL), Schenectady, New York, October 1994.

MCKENNEY, Timothy L., Lieutenant, USN, "Environmentally Safe and Economically Sound Method of Ship Scrapping," SNAME Annual Meeting, New Orleans, Louisiana, 15 November 1994.

MOURING, Sarah E., Assistant Professor, "A Theoretical Analysis of the Planar Motions of a Single Point Moored Ship in a Steady Current," Marine Technology Conference, Washington, D.C., 8 September 1994.

NEHRLING, Bruce N., Professor, Co-presenter, "Some Observations on Experimental Techniques for Modeling Ship Stability in Wind and Wave," Fifth International Conference on Stability of Ships and Ocean Vehicles (STAB '94), Melbourne, Florida, 7-11 November 1994.

NELSON, Martin E., Professor, R. N. MEHTA, and M. MISRA, "Triboelectrification Assisted Air Classification Process for Removal of Radionuclides from Contaminated Soils," Fourth Annual Conference on Contaminated Soils, University of Massachusetts, Amherst Massachusetts, 17-20 Oct 1994.

NELSON, Martin E., Professor, Andrew D. BUCKON, Lieutenant, USN, and Mark J. Harper, Assistant Professor, "Soil Remediation Using Air Classification Technology," New Orleans, Louisiana, 23 June 1994.

NELSON, Martin E., Professor, Andrew D. Buckon, Lieutenant, USN, "Air Classification Technology for Removal of Heavy Metals from DOE Soils," DOE Conference, Reno, Nevada, 3 August 1994.

NELSON, Martin E., Professor, Mark J. Harper, Assistant Professor, and Andrew D. BUCKON,

Lieutenant, USN, "Air Separation of Heavy Metal Contaminates from DOE Soils," TMS Annual Meeting, Las Vegas, Nevada, 14 February 1995.

TUTTLE, Kenneth L., Associate Professor, "Combustion Generated Emissions in Marine Propulsion Systems," SNAME, Great Lakes Section, Cleveland, Ohio, 19 May 1995.

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# Hydromechanics Laboratory

Professor Roger H. Compton  
Director

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The primary function of the Naval Academy Hydromechanics Laboratory (NAHL) is to support education and research in ship hydromechanics and ocean engineering. The facilities which constitute the NAHL are:

(1) 380 Foot Towing Tank (380'x26'x16') - This premier facility features two towing carriages and a servo-controlled, electrohydraulically activated, dual flap wavemaker. Both towed and self-powered ship models can be tested in calm water, regular waves, and irregular waves. All waves generated are long-crested. A modular wind generation system capable of producing scale winds exceeding 100 knots is available. Open water propeller characteristics can be determined by means of a propeller boat. Maneuvering characteristics can be evaluated by means of a large amplitude, horizontal planar motions mechanism. Most testing is done at model speeds up to 25 fps, but special tests have been run at speeds as high as 48 fps. Surface ship and submarine models can be tested. A drydock and finger pier located at the North End of the basin can be isolated from the main tank by means of closeable drydock doors.

(2) 120 Foot Towing Tank (120'x8'x5.5') - Ship models up to about 6 feet in length can be towed in calm water, regular waves, and irregular waves. Long-crested waves can be generated by a wavemaker which is effectively a 1/3 scale model of the wavemaker in the 380 foot towing tank. Both deep and shallow water experiments are run in this facility. The tank can be configured with a false bottom to simulate various shoaling water conditions. The capability to do wind testing is planned due to the modular nature of the 380 foot tank system. The powered carriage can attain speeds as high as 13 fps. The tank is also equipped to perform gravity tow (constant force) model testing.

(3) Coastal Engineering Tank (52'x48'x2') - This L-shaped tank is equipped with a piston-type wavemaker and a moveable bridge for positioning wave probes. Small scale breakwaters, groins, jetties, and harbor arrangements can be studied with respect to wave reflection, refraction, transmission, and absorption properties. Wave guides allow the basin to be subdivided for multiple experimental setups. A small circular wave tank can be erected within the main tank to study wave induced littoral transport phenomena.

(4) Circulating Water Channel (Test Section

5'x1.3'x1.3') - This small, free-surface water channel with a top speed of 12 fps is used primarily for flow visualization around control surface models and cavitating propeller models. Quantitative measurements of hydrodynamic forces on rudders and hydrofoils have also been made. The channel can be pressurized from +6 psig to -12 psig to adjust model cavitation numbers.

(5) Computer Workstations - A number of Hewlett-Packard and Gateway 486 PC workstations are available for midshipman, staff, and faculty use to acquire and analyze measured data and to define hull shapes using the FASTSHIP program. The capability exists to use the FASTSHIP offset files to cut hull models on a numerically-controlled milling machine located adjacent to the NAHL.

(6) Stability/Ballast Tank (24'x12'x3.5') - This tank is used to investigate the hydrostatic stability characteristics of ship models--inclining experiments and righting arm experiments--as well as being used to ballast models in preparation for testing in the 380 foot or the 120 foot towing tanks.

All of the operating facilities are electronically linked via a local network to a host computer located in the control room for the 380 foot tank. The host computer not only permits speed and consistency in data acquisition and analysis from all facilities, but is integral to the control and sequencing of experimental hardware used in testing. The NAHL Staff is a small, multi-talented group which plans, sets-up, performs, and interprets the measured data from experimental programs undertaken for midshipmen, faculty, and certain outside governmental agencies. The staff of 9 consists of 5 graduate engineers/naval architects, 3 engineering technicians, and an office manager/secretary. Liaison with the Naval Academy faculty is maintained by an appointed Laboratory Director who is also a member of the teaching faculty.

Academic programs continue to reflect the synergistic benefits of the Laboratory participation in significant research efforts for the Navy and Coast Guard. Programs have included:

(1) Fisheries patrol craft testing U.S. Army Corps of Engineers (USA/CE) (2) Physical modelling of a current U.S. Coast Guard Cutter (USCGC) at zero speed in winds and waves for direct correlation with full scale trials results Naval Sea Systems Command (NAVSEA); (3) Submarine series testing of tail cone/control surface

configuration variations Naval Surface Warfare Center (NSWC), Panama City, Florida; (4) Testing of advanced multi-hulled concept-cooperative research Massachusetts Institute of Technology (MIT); (5) Nonlinear ship response phenomena Naval Civil Engineering Lab (NCEL); (6) Autonomous Underwater Vehicle dynamics - cooperative research NSWC, Annapolis, Maryland; (7) Ocean wave group characteristics studies Office of Naval Research (ONR); (8) Physical modelling of a shallow water mine

neutralization system NSWC Annapolis; (9) Compliant tower testing in waves National Science Foundation (NSF).

Experimental research studies with intense student involvement have included the following: (1) Human powered submarine propeller testing; (2) Racing oar blade hydrodynamics; (3) Planing boat testing technique evaluation; (4) Wave attenuation of circular cylinder arrays; (5) Surface wave dynamics in the vicinity of a submerged step.

## Publications

COMPTON, Roger H., Professor, co-author, "Intact Stability Criteria Revision Project (Part I): Model Test Predications of Sea Trial Performance of Two U.S. Coast Guard Cutters - Zero Speed Pitch and Roll Motions in Wind and Waves", Report #EW-19-93, October 1993.

The realistic assessment of ship stability in typical and severe sea conditions requires dynamic as well as static analysis methods. Thus, the classical naval architectural technologies of intact/damaged stability and seakeeping are rapidly becoming inseparable. An international effort to review, improve, and update ship stability criteria has employed physical scale modelling, analytical modelling, and full scale sea trials to understand and be able to develop criteria which insure adequate safety for ship loading over a ship's life.

The U.S. Naval Academy Hydromechanics Laboratory (NAHL) has been involved in this criteria development process primarily in the performance of physical scale model experimentation in wind, waves, and combined wind and wave environments.

The roll and pitch motions of two intact U.S. Coast Guard cutter classes - WMEC BEAR and WHEC HAMILTON - were investigated experimentally in the 380 foot towing tank of the U.S. Naval Academy Hydromechanics Laboratory. Both hulls were fully appended and had three dimensional block superstructures fitted. They were softly tethered at zero forward speed at head, bow, beam, quartering, and following sea conditions in long crested irregular wave systems and in Froude scaled wind conditions corresponding to Sea States 6 and 7. Motion statistics - average heel angle, standard deviations of roll and pitch, roll and pitch maxima recorded during a nominal (full scale) 30 minute exposure time - are presented in both tabular and graphical formats. Statistics are presented primarily for combined wind and wave excitation, but selected data conditions for "wind only" and "waves only" conditions are also presented.

COMPTON, Roger H., Professor, co-author, "Intact Stability Criteria Revision Project (Part III): Model

Testing of a U.S. Coast Guard Cutter's Roll Dynamics for FREDYN Development Efforts," Report #EW-08-94, August 1994.

An ongoing international effort to review, improve, and update ship stability criteria has employed physical scale modeling, analytical modeling, and full scale sea trials to understand and develop criteria which insure adequate safety over a ship's life.

The NAHL has been involved in this criteria development process primarily in the performance of physical scale model experimentation in wind, waves, and combined wind and wave environments.

Fundamental roll dynamic parameters such as natural periods, decay coefficients, and virtual inertia for ships are derived more easily from model test procedures than from full scale, at-sea testing. To assist the computer analysts who are developing FREDYN, a state-of-the-art, time domain ship motion and stability program, several such "simple" experiments were conducted using a HAMILTON Class cutter model.

A number of sallying experiments were conducted at zero speed to quantify the effects of the NAHL soft restraint system on roll motion dynamics, and the influence of various underwater appendages. Sallying experiments over a range of forward speeds were conducted to examine speed effects. Zero speed beam sea rolling in long crested, regular waves was performed for a variety of model loadings, wave steepness, and wave frequencies. Zero speed rolling in long crested irregular waves was done with and without beam winds to study the damping effect of wind.

LAWSON, Richard B., Midshipman, "The Model Testing of Planing Hulls: Effects of Experimental Methods", Chesapeake Section, Society of Naval Architects and Marine Engineers, Alexandria, VA, 11 April 1995.

Towed model testing of planing hulls requires that special attention be paid to those hydrodynamic factors which characterize the planing phenomenon. These include: (1) Speed dependent characteristic flow lengths

and wetted surfaces; (2) Relationship of thrust vector to hull-location and direction; (3) Separation of flow at transom (Kutta Condition); (4) Separation of flow along chines (or spray strips); (5) Interdependence of resistance and running trim angle over speed range; (6) Aerodynamic drag of hull at high speeds. Additionally, turbulence stimulation on a small model must be addressed differently due to trim and lift. A series of carefully controlled model tests of a nominal 40 foot long, 40,000 pound, hard chine planing boat was designed and performed to address these issues. The major findings were: (1) The detailed geometry of artificial devices to ensure flow separation at the model transom (e.g., mylar strips) has a major effect on both resistance and running trim angle; (2) At high speeds, the aerodynamic drag of the model under the carriage is measurable and should be accounted for; (3) Turbulence stimulation by artificial means is rendered less significant due to high velocities; (4) Calculation and application of an unloading force on a free-to-trim, free-to-rise model is a viable experimental technique; (5) Measurement of wetted lengths and the resulting calculated characteristic length and wetted surface at each speed is a necessary complication for planing boat model testing.

SHAUGHNESSY, James J., Naval Architect, co-author, "Some Observations on Experimental Techniques for Model Ship Stability in Wind and Waves," *Proceedings of the Fifth International Conference on Stability of Ships and Ocean Vehicles (STAB '94)*, Melbourne, Florida, November 1994.

A series of experiments for measuring the intact and damaged stability characteristics of scale ship models in wind and waves have recently been conducted at the United States Naval Academy's Hydromechanics Laboratory. The equipment which was developed for these experiments, the pros and cons of the various modeling techniques which were investigated, and some general conclusions and observations about these experiments are described in this paper.

The generation, measurement, and behavior of the wind field is discussed. The wind field was generated by sets of centrifugal fans spanning the width of the Academy's larger towing tank. The wind field was mapped by using electro-mechanical anemometers. The behavior of a wind field in an enclosed towing tank places special requirements on the size and position of the ship model, its restraint system, and on the subsequent analysis of the acquired data. Model tethering considerations are addressed. The influence of a simplified 2D superstructure versus a more realistic but costly 3D superstructure is discussed.

Experiences gained with the use of a non-intrusive system to video tape the model's motions and the subsequent computer analysis of this time history are

described. The relative influences that wind only, waves only, and wind and waves have on a model's behavior are compared.

SHAUGHNESSY, James J., Naval Architect, co-author, "Intact Stability Criteria Revision Project (Part II): Model Test Validation of Sea Trial Performance of a U.S. Coast Guard 378' High Endurance Cutter: Zero Speed Pitch and Roll Motions in Wind and Waves; Pitch and Heave Motions in Head and Following Seas," Report #EW-07-94, July 1994.

An ongoing international effort to review, improve, and update ship stability criteria has employed physical scale modeling, analytical modeling, and full scale sea trials to understand and develop criteria which insure adequate safety over a ship's life.

The NAHL has been involved in this criteria development process primarily in the performance of physical scale model experimentation in wind, waves, and combined wind and wave environments.

Following full scale trials of the USCGC BOUTWELL, a HAMILTON class cutter, in the Gulf of Alaska during January of 1994, the NAHL conducted an experimental program intended to recreate, in the laboratory, selected conditions experienced at sea by the BOUTWELL. Six specific data runs from the sea trials were simulated in the 380 foot towing tank at NAHL. Three involved testing at zero forward speed in wind and wave conditions at various relative headings; three involved irregular wave testing at Froude scaled ship speeds in head and following sea conditions. Pitch, roll and vertical acceleration data were acquired from the model in the zero speed wind and wave tests; pitch and heave data were acquired from the at-speed test. Model data and full scale trial data were correlated and discussed.

ZSELECZKY, John J., Naval Architect, "EHP Model Tests of USNA Model YP-81-5 with an Extended Afterbody & Stern Wedges," U.S. Naval Academy Division of Engineering and Weapons Report EW-12-94.

The Marine Design Center of the U.S. Army Corps of Engineers has been designing a new fisheries research vessel, intended for use on the Great Lakes. Many characteristics of the new hull design were similar to those of models used in a systematic series of model tests conducted at the Naval Academy in 1985 (reported by Compton in SNAME Marine Technology, 1986). By adding an extension to the stern of the Naval Academy's model YP-81-5, the main characteristics of the model nearly matched those of the new hull. The model was outfitted with 5, 10 and 15 degree stern wedges, and tested over a range of scaled speeds from 8 to 22 knots. Tests were conducted with the model

ballasted at one displacement and with the center of gravity at two longitudinal locations. Speed, resistance, trim and rise were measured and are presented in the report in graphic and tabular form.

ZSELECZKY, John J., Naval Architect, WALLENDORF, Louise A., Ocean Engineer, "Extreme Roll Motions of a Navy Frigate Model in Large Beam Seas," U.S. Naval Academy Division of Engineering and Weapons Report EW-20-94.

Model tests were conducted in the Naval Academy Hydromechanics Laboratory's 380 foot towing tank to measure roll motions of a frigate model in large beam seas. The main goal of the tests was to obtain high-quality measurement data of a complex, nonlinear

process in order to evaluate a new nonlinear systems identification technique. The new technique, referred to as "Reverse MI/SO" (Multiple Input, Single Output) has been developed by investigators at the Naval Facilities Engineering Service Center, who sponsored the work. For these experiments, the single input into the system was the wave elevation record in extreme, quasi-random waves. Outputs from the system were the roll, heave and sway of the model when positioned beam-to the waves. Motions were measured using a video motion analysis system and were synchronized with wave measurements from a wave probe. All of the data were digitized and stored in ASCII files that were provided to the sponsor. The report gives details of the test conditions, procedures and techniques that were used to obtain the test data.

## Presentations

COMPTON, Roger H., Professor, "Some Observations on Experimental Techniques for Modeling Ship Stability in Wind and Waves," Fifth International Conference on Stability of Ships and Ocean Vehicles (STAB '94), Melbourne, Florida, 7-11 November 1994.

LAWSON, Richard B., Midshipman, "The Model Testing of Planing Hulls: Effects of Experimental Methods", Chesapeake Section, Society of Naval Architects and Marine Engineers, Alexandria, VA, 11 April 1995.

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# Weapons and Systems Engineering

Professor R. DeMoyer  
Chair

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**R**esearch within the Weapons and Systems Engineering Department continues to provide the faculty with an opportunity to grow professionally and to keep abreast of rapidly advancing systems technology. In addition, every graduating Systems Engineering major participates in independent research, design, and development projects for the purpose of realizing practical applications of some of the theory which they have studied.

Every faculty member, both civilian and military, either participates in independent research in areas of interest to the U.S. Navy or supports midshipmen research programs in an advisory capacity. Faculty research areas currently include high precision electrical measurements, drone aircraft landing systems, magnetic bearing noise attenuation, and target detection using infrared data.

This year there were two Trident Scholars in the Systems Engineering Department. They engaged in extensive research projects in lieu of several courses. Their research topics were firearms identification using pattern analysis, and the use of digital signal processing for acoustic analysis.

Several midshipmen worked with faculty advisors in individual research courses. Topics addressed include a computer implemented oscilloscope, robotic adaption and navigation using sensor technology, high precision inductive voltage dividers, and machine intelligence.

Strong emphasis continues on the faculty-midshipman relationship during the individual research oriented capstone design course. Each midshipman is assigned both an administrative and a technical advisor. These advisors not only provide support of a technical nature, but also emphasize planning, scheduling, and effective oral and written presentation. Typical examples of midshipmen research projects include development of autonomous carts and boats, automatic target detection, magnetic levitation, and vibration control.

Funding for research continues to be diverse. This year sponsors included the Naval Academy Research Council, the Office of Naval Research, the Naval Research Lab, the Naval Surface Warfare Center at Carderock, and the National Institute of Standards and Technology.

## Sponsored Research

### High Precision Capacitance Bridge

Researcher: Assistant Professor Svetlana Avramov-Zamurovic  
Sponsor: National Institute of Science and Technology (NIST)

To support the Single Electron Tunneling experiment metrology, two capacitance bridges have to be developed and fully characterized so that errors in measuring the capacitance can be estimated. The bridge that has an operating mode up to 2 kHz has the

inductive voltage dividers in one of the bridge arms. The bridge that measures the change in the voltage levels on the tested capacitor uses resistive dividers. Simple circuits were developed and the test procedures suggested. Instrumentation interfacing is in progress.

### Automatic Landing System for Drone Aircraft

Researchers: Assistant Professor William I. Clement and Professor Kenneth A. Knowles  
Sponsor: Naval Research Lab (NRL)

This research focused on the design and construction of a prototype machine vision-based automatic landing system for unmanned drone aircraft. The system must

be deployable on a wide variety of naval platforms and must interface easily with the human operator of the drone during the transition from flight to landing.



Robustness is key to the success of such a system and was the driving force throughout the design and testing phases.

A radio-controlled glider was constructed and infrared laser diodes were mounted on the leading edge of the wing. The boom and capture mechanism were designed and construction is still underway. The machine vision system, including video multiplexer and multiple cameras, was tested and experiments were performed to determine the best configuration of aperture and lens filter to reduce the effects of ambient infrared light on the tracking problem. The software to

track the drone and generate control signals was written (in "C") and debugged, including the ability to switch between cameras without losing track. The circuitry necessary to allow the computer to control the flight surfaces of the aircraft was also prototyped and tested. A printed-circuit version will be constructed.

Only one flight test was performed in this first research phase. It was unsuccessful. The sponsor was highly satisfied with the research progress, however, and additional funds have been granted for one, and possibly two, additional years.

### **Firearms Identification Using Pattern Analysis and Computational Modeling**

Researcher: Midshipman 1/C Foo S. Jiong, USN

Adviser: Assistant Professor Carl E. Wick

Sponsor: Trident Scholar Programs

This project seeks to apply modern digital image processing techniques to the problem of determining the source firearm from the markings on a projectile. The researcher is determining methods for automating image data collection, for the presentation of the image

data in meaningful ways, for the processing of the data to enhance projectile markings, and for metrics to measure the markings in a way that they can be compared with other test projectiles.

### **Employing Digital Signal Processing for Acoustical Analysis**

Researcher: Midshipman 1/C Brannen G. McElmurray, USN

Adviser: Assistant Professor Carl E. Wick

Sponsor: Trident Scholar Program

This project seeks to apply a digital signal processor to the task of demodulating the signals that are produced by sonar buoys that are commonly used in anti-submarine warfare. To accomplish this task, the

research must innovate digital filtering techniques that can separate five separate signals that are sent together in one data stream.

### **Active Feedback Noise Control of a Magnetic Bearing Pump**

Researcher: Assistant George E. Piper

Sponsor: Naval Surface Warfare Center - Annapolis Detachment

The purpose of this project is to apply active feedback control techniques to attenuate fluid-borne noise on an existing magnetic bearing pump. The principle, analysis, and experimental results of active feedback noise control were explored for single input - single output cases. Good correlation was shown between analysis and test results. Two different controller designs were developed. The first design used plant inversion with loop shaping. The second design used a

feedback loop within the controller itself. Time delays resulting from acoustic propagation decreased stability thus restricting the noise attenuation bandwidth. The first controller design demonstrated good noise attenuation over a narrow bandwidth. However, noise attenuation degraded for wider bandwidths. The second controller design demonstrated poor attenuation over a limited bandwidth. Work on project is on going.

## **Target Detection Using Spatial and Spectral Information Contained in Infrared Data**

Researcher: Assistant Professor Carl E. Wick

Sponsor: Naval Research Lab (Optical Sciences Division)

The objective of this task was to develop new methods for detecting targets using spatial and spectral information provided by various types of infrared sensors. A series of experiments were carried out at remote sites on military-type targets, in which a considerable amount of spatial-spectral data was obtained. Some initial data processing algorithms were

constructed that would allow manipulation and measurement to be made on these very large image data "cubes" (spatial-spectral dimensions). The lessons learned from this exercise have provided useful information about image display and processing requirements for even larger amounts of image data that are expected from other sources in the near future.

## **Independent Research**

### **Computer-Aided Graphical Design of Feedback System Controllers Using the Rotated Inverse Polar Plot**

Researcher: Associate Professor Thomas E. Bechert

Cascade compensators improve the performance of feedback control systems by providing adequate phase margin and system bandwidth. Design of compensators with these desirable properties is a challenging trial and error procedure, when classical Bode techniques are used. This project has produced a user-friendly computer-aided graphical design procedure which is based on Nyquist polar plots instead of Bode plots.

The simplicity of the method derives from the fact that a family of compensators with various center frequencies shows up as a family of curves on a Bode plot, but as a single curve on a polar plot. This feature is exploited in the design process. A number of features from the MATLAB Graphical User Interface package have been utilized to make the method practical and feasible.

## **Research Course Projects**

### **Binary Inductive Voltage Dividers (BIVD)**

Researchers: Midshipmen 2/C Paul J. Frontera, Aaron M. Still, Ryan M. Stone and Ryan T. Tewell, USN

Adviser: Assistant Professor Svetlana Avramov-Zamurovic

During this project the students became familiar with various instrumentation and made an attempt to design the elements of an inductive voltage divider bridge. The first phase of the project was to fabricate several 8-bit binary dividers and an isolation transformer for the capacitance bridge used in the NASA's Critical Viscosity of Xenon experiment. The second phase of the project was to test developed transformers. The

copy of the bridge circuit board that will be used in space was provided by National Institute of Standards and Technology so the students could build the bridge and test the transformers on the actual flight hardware. The third phase of the project was to interface the instrumentation with the computer and perform the automatic measurements.

## **Development of a Computer Scope**

Researcher: Midshipman 1/C Zachary K. Gillen, USN

Adviser: Professor E. Eugene Mitchell

The objective of this project was to investigate the possibility of building an oscilloscope on a computer. The goal is to input data into a box that is connected to the parallel port of a PC. The capabilities will be severely limited with respect to commercial scopes, but if done simply enough, it would be a very useful tool.

The total project will take several semesters, this

project was to be a preliminary investigation, a first step.

The results of the investigation were as follows: the overall project is feasible, the basic design is now known, most of the details have been laid out. The problem of development remains.

## **Robotic Adaption Utilizing Sensor Technology**

Researcher: Midshipman 1/C Matthew J. Kawas, USN

Adviser: Professor Kenneth A. Knowles

This research effort built upon the sensor-driven control algorithms for the SCORBOT ER-V Plus robot arm, which were developed during the preceding semester research (Kawas, Robotic Navigation of a Complex Environment Using Exteroceptive Sensors). The first phase of this research involved the adaption of Force Sensing Resistors (FSRs) to the end effector to permit

compliant motion around obstacles. The second phase of the research consisted of developing and implementing fiber optic reflective proximity sensors to permit end effector movement around obstacles. Both techniques were successful in enabling sightless two-dimensional navigation of simple arbitrary maze obstacles.

## **Robot Navigation of a Complex Environment Using Exteroceptive Sensors**

Researcher: Midshipman 1/C Matthew J. Kawas, USN

Adviser: Professor Kenneth A. Knowles

This research effort consisted of developing control algorithms to permit a robot to navigate its end effector through an arbitrary two-dimensional maze path. A reconfigurable peg board maze was designed and constructed to permit establishing arbitrary maze paths. Using images obtained by a vertical camera, control algorithms were developed to guide the vertical end effector of a SCORBOT ER-V Plus robot arm along a

successful horizontal 2-D path through the maze. After successful completion of this part of the project, a six degree-of-freedom force/torque ("wrench") sensor was fitted with a wand extension and a gripper handle. The robot grasped the gripper handle, and then attempted to navigate the vertical wand through the 2-D maze path. Algorithms were developed to utilize the wrench sensor signals to permit successful navigation of the maze.

## **An Application of the Subsumption Architecture**

Researcher: Midshipman 1/C Jason G. Williscroft, USN

Adviser: Professor Kenneth A. Knowles

The traditional approach to machine intelligence involves progression of information from perception, through representation and cognition, and finally to action. In actual implementation, this approach typically is neither fast nor robust enough to support a mobile robot operating in a dynamic, unpredictable real-time environment. A relatively new concept, called reactive or behavior-based intelligence, attempts to circumvent the problems associated with traditional

approaches by directly linking perception to action through a network of comparatively simple reflexive control systems. This research developed a control scheme for a hypothetical behavior-based robot called TAZ, which will permit fully autonomous operation in a cluttered, dynamic environment. Using a network of asynchronous controllers arranged into a subsumptive architecture, TAZ has the capabilities to: avoid contact with objects (stationary and moving); wander aimlessly

around without hitting obstacles; and then "explore" the local environment by locating distant targets that appear

reachable, and then heading toward them (while locating other attractive targets).

## Research Course Projects

Each Systems Engineering major enrolls in ES402, Systems Engineering Design, during senior year. This course is the capstone of the Systems Engineering curriculum. The student is required to propose, design, construct, test, demonstrate, and evaluate a system of particular personal or general professional interest.

The ES402 design course requires the combined effort of the total Systems Engineering Department

faculty. Military instructors normally function as project monitors and help with organization, administration, and scheduling of individual projects. Civilian faculty function as technical advisors, and military and civilian technicians supply the hands-on technical help.

The results of academic year 1994-1995:

### **Integrated Home Monitoring System**

Midshipmen 1/C Khaled Aboul-Seoud  
and Robert W. Smith, USN

Adviser: Lieutenant Commander Duncan F. O'Mara, USN

### **Tracking Security Camera**

Midshipmen 1/C Alessandro V. Alevorio  
and Jarret L. Roth, USN

Adviser: Lieutenant Commander Paul E. Thurman, USN

### **Voice-Controlled CD Player**

Midshipmen 1/C Jon M. Anderson  
and Daniel J. Holman, USN

Adviser: Lieutenant Commander Earl F. Goodson, USN

### **Wheel Chair Controller**

Midshipmen 1/C Theodore J. Andrews  
and Benjamin P. Tolerba, USN

Adviser: Lieutenant Commander Paul E. Thurman, USN

### **Coffee Delivery System**

Midshipmen 1/C Matthew J. Armas  
and John T. Phelan, USN

Adviser: Lieutenant Commander Duncan F. O'Mara, USN

### **Automatic Window Tinting System**

Midshipmen 1/C Corey M. Avens  
and Donald L. George, USN

Adviser: Lieutenant Dennis A. Maloney, USN

### **Autonomous Undersea Vehicle**

Midshipmen 1/C Marc X. Baca  
and Robert A. Wolf, USN

Adviser: Commander John A. Hancock, USN

### **Laser Finish Line for Crew Regatta**

Midshipmen 1/C Erik R. Baker  
and Eric W. Tansky, USN

Adviser: Lieutenant Dennis A. Maloney, USN

**Systems Boat**

Midshipmen 1/C Robert C. Bandy,  
Daniel A. Herman and Karl W. Wick, USN  
Adviser: Commander John A. Hancock, USN

**Systems Ball Competition**

Midshipmen Charles J. Basham  
and Steven J. Bellack, USN  
Adviser: Lieutenant James L. Tangorra, USN

**Chess Master**

Midshipmen 1/C James A. Bates, Jr.,  
Robert D. Curry and Paul D. Thiry, USN  
Adviser: Lieutenant Commander David R. Gillingham, USN

**Systems Ball Competition**

Midshipmen 1/C Basil A. Blastos  
and Raymond A. Santacruz, USN  
Adviser: Commander William H. Campbell, USN

**Active Magnetic Bearing Control**

Midshipmen 1/C Stephen L. Bocanegra,  
Angelique L. Cary, Raymond Y. Rodriguez  
and Rebecca L. Tschampl, USN  
Adviser: Lieutenant Commander Richard E. Farrell, USN

**Systems Ball Competition**

Midshipmen 1/C Jason K. Brandt  
and Jason E. Ritz, USN  
Adviser: Commander John A. Hancock, USN

**Autonomous Robotic Vehicle and Manipulation**

Midshipmen 1/C Timothy M. Brosnan,  
Jason O. Burkholder and Michael J. Howard, USN  
Adviser: Commander William H. Campbell, USN

**Active Noise Control**

Midshipmen 1/C Christopher H. Canales  
and Andrew P. Gnau, USN  
Adviser: Lieutenant Commander Duncan F. O'Mara, USN

**Automatic Toll Payer**

Midshipmen 1/C Andrew F. Carlson  
and Jonathan R. Hurst, USN  
Adviser: Lieutenant Dennis A. Maloney, USN

**Systems Ball Competition**

Midshipmen 1/C Brian J. Clark  
and Scott P. Smith, USN  
Adviser: Commander William H. Campbell, USN

**Voice-Controlled Water Jet Craft**

Midshipmen 1/C Michael B. Davies,  
Todd C. Fink and Anthony R. Gonzalez, USN  
Adviser: Lieutenant Commander Duncan F. O'Mara, USN

## WEAPONS AND SYSTEMS ENGINEERING

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### **Digital Water Temperature and Pressure Regulator**

Midshipman 1/C Daniel A. Devos, USN

Adviser: Major Donald S. Smith, USMC

### **Dynamic Braking System**

Midshipmen 1/C Kevin T. Doney

and James N. Patterson, USN

Adviser: Commander William H. Campbell, USN

### **Digital Telephone Answering Machine**

Midshipman John J. Down, USN

Adviser: Lieutenant Commander Patrick D. Gardner, USN

### **Systems Ball Competition**

Midshipmen Dennis L. Farrell

and Ryan K. Mahelona, USN

Adviser: Lieutenant Dennis A. Maloney, USN

### **Close-In Paintball System (CIPS)**

Midshipmen 1/C Jonathon E. Frey

and Gregory N. Zima, USN

Adviser: Lieutenant Commander Christopher H. Jensen, USN

### **Voice-Controlled Remote Vehicle**

Midshipmen 1/C Patrick J. Gallagher

and Randy L. Studt, USN

Adviser: Professor Terrence E. Dwan

### **Systems Boat**

Midshipmen 1/C Sean D. Fujimoto

and Jeffrey L. Heidsieck, USN

Adviser: Lieutenant Commander Earl F. Goodson, USN

### **F.U.B.A.R. Car**

Midshipmen 1/C Kenneth W. Grzymalski

and Jon R. Kirsch, USN

Adviser: Lieutenant Commander Paul E. Thurman, USN

### **Automatic Windshield Wiper System**

Midshipmen 1/C Eric J. Hamstra

and Brian D. Swanson, USN

Adviser: Commander William H. Campbell, USN

### **Optically Guided Tracking Cart**

Midshipmen 1/C Thomas W. Henneberg

and Garrick M. Joseph, USN

Adviser: Lieutenant Commander David R. Gillingham, USN

### **Automatic Tank Killer**

Midshipmen 1/C David T. Jenkins

and Ross H. Piper III, USN

Adviser: Commander John A. Hancock, USN

### **Eigen 500 Racer**

Midshipman 1/C Aaron E. Kelinman, USN

Adviser: Captain Charles B. McClelland, USMC

## WEAPONS AND SYSTEMS ENGINEERING

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### **Automatically Controlled Buoyancy Compensator**

Midshipmen 1/C Robert W. Klemeyer  
and Joshua A. Sager, USN

Adviser: Lieutenant Commander Paul E. Thurman, USN

### **Magnetic Propulsion**

Midshipmen 1/C Brigand W. Kline  
and Anil Phul, USN

Adviser: Lieutenant Commander Richard E. Farrell, USN

### **Velocity-Controlled Agricultural Sprayer System**

Midshipman 1/C Brian S. Knowles, USN

Adviser: Lieutenant Commander Christopher H. Jensen, USN

### **Systems Ball Competition**

Midshipmen 1/C David A. Law  
and Michael C. McGarity, USN

Adviser: Lieutenant Commander Earl F. Goodson, USN

### **Noise-Compensated Radio Volume Control**

Midshipmen 1/C Matthew E. Limbert  
and Ronnie E. Mahofski, USN

Adviser: Lieutenant Commander Richard E. Farrell, USN

### **Networked Differential GPS**

Midshipmen 1/C Brian T. Lindoerfer  
and Kyle A. Miller, USN

Adviser: Lieutenant Commander Patrick D. Gardner, USN

### **Remote Sentry**

Midshipman 1/C Gordon J. Lyssy, USN

Adviser: Lieutenant Commander Earl F. Goodson, USN

### **Systems Ball Competition**

Midshipmen 1/C Daniel P. Malatesta  
and David K. Richardson, USN

Adviser: Commander Charles A. Floyd, USN

### **IFF/Laser Energy**

Midshipman 1/C Grayson B. Morgan, USN

Adviser: Associate Professor Olaf N. Rask

### **Telemetry Satellite Communications**

Midshipman 1/C John Mui, USN

Adviser: Lieutenant Commander Patrick D. Gardner, USN

### **Robotic Arm Force Sensor/Mouse Control**

Midshipmen 1/C Krista Murphy  
and Adam T. Scott, USN

Advisers: Captain Charles B. McClelland  
and Major Donald S. Smith, USMC

### **Hybrid Electric Vehicle**

Midshipman 1/C Matthew W. Murphy, USN

Adviser: Lieutenant James L. Tangorra, USN

## WEAPONS AND SYSTEMS ENGINEERING

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### **Systems Ball Competition**

Midshipmen 1/C Mark W. Nave  
and Glenn M. Zeigler, USN

Adviser: Lieutenant Commander David R. Gillingham, USN

### **Systems Ball Competition**

Midshipmen 1/C Jeffrey B. Parsons  
and Christopher S. Weller, USN

Adviser: Lieutenant Commander Duncan F. O'Mara, USN

### **Systems Boat**

Midshipmen 1/C Erik J. Paulson  
and Christopher J. Tarsa, USN

Adviser: Lieutenant Commander Duncan F. O'Mara, USN

### **Eigen 500 Vehicle Control**

Midshipmen 1/C Brian J. Peck  
and Eric A. Stenzel, USN

Adviser: Lieutenant Commander Christopher H. Jensen, USN

### **Drinking/Driving Prevention System**

Midshipman 1/C Gregory K. Pavlyak, USN  
Adviser: Major Donald S. Smith, USMC

### **Automatic Tracking Vehicle**

Midshipman 1/C William C. Pritchell, USN

Adviser: Lieutenant Commander Christopher H. Jensen, USN

### **UNREP Assistant**

Midshipman 1/C Christopher L. Smith, USN  
Adviser: Lieutenant James L. Tangorra, USN

### **Ergonomic Fan**

Midshipman 1/C John A. Strickland, USN  
Adviser: Commander Charles A. Floyd, USN

### **Satellite Orientation Control**

Midshipman 1/C Jason M. Stripinis, USN  
Adviser: Major Donald S. Smith, USMC

### **Home Security System**

Midshipman 1/C William R. Taff, USN  
Adviser: Associate Professor Olaf N. Rask

### **Remote Weather Station**

Midshipman 1/C Ward Y. Tom, USN  
Adviser: Lieutenant Commander Patrick D. Gardner, USN

### **Digital Automobile Alarm**

Midshipman 1/C David M. Trujillo, USN  
Adviser: Captain Charles B. McClelland, USMC

### **Subsumption Architecture With Walking Robot**

Midshipman 1/C Jason G. Williscroft, USN  
Adviser: Commander Charles A. Floyd, USN



## Publications

AVRAMOV-ZAMUROVIC, Svetlana, et. al. Assistant Professor, "Inductive Voltage Divider Calibration for NASA Flight Experiment." *CAL LAB, The Magazine for Calibration Laboratory Managers, Vol. 1, No. 4, July 1994*. (This is a reprint from the 1993 National Conference of Standard Laboratories Proceedings where the paper got The Best Paper Award.)

The inductive Voltage Dividers (IVDs) used in the thermostat of NASA's Zeno experiment were tested using an automatic IVD bridge developed at the National Institute of Standards and Technology (NIST). To achieve 10 mK temperature control, the thermostat must be able to measure resistance ratios with the differential linearity of 0.1 part-per million. The test results show that within a ratio range of 0.5 to 0.6 at frequencies between 200hz and 400 hz, the thermostat IVDs were linear to 0.07 ppm.

AVRAMOV-ZAMUROVIC, Svetlana, Assistant Professor, "Construction of Inductive Voltage Dividers and Isolation Transformers for the Critical Viscosity of Xenon Experiment." *Report to National Institute of Standards and Technology*. February 1995.

To support the metrology of the Critical Viscosity of Xenon Experiment two types of transformers were constructed. To isolate the voltage source from the measurement bridge and scale the input signal an isolation transformer was developed. To perform viscosity measurements the bridge is used that consists of capacitance arm and inductive voltage divider arm. To provide the sufficient resolution for the bridge balance 8-bit inductive voltage divider was designed. All the transformer were tested and had satisfactory performance.

CLEMENT, William I., Assistant Professor and Doney, George D., "An Artificial Neural Network Boiling Detector for Nuclear Reactors." *International Journal of Power and Energy Systems*, September 1994.

Experiments were performed on the effects of changing bulk temperature and power levels on the sound of boiling in a small research nuclear reactor. The goal was to develop an artificial neural network based boiling detector for the purpose of expanding the envelope of safe operation of the reactor. Acoustic data was collected and back-propagation neural network trained to recognize boiling under a variety of conditions. One hundred percent accuracy was achieved for the limited range of experiments performed.

CLEMENT, William I., Assistant Professor, and George D. Doney., "A Software-Based Artificial Neural Network Boiling Detector for Nuclear Reactors." *Computers in Education Journal* of the American Society for Engineering Education, January 1995.

The flexibility of a software-based artificial neural network for pattern recognition is demonstrated in experiments with boiling detection in a nuclear reactor. Experiments were performed on the effects of changing bulk temperature and power levels on the sound of boiling in a small research nuclear reactor. The goal was to develop an artificial neural network based boiling detector for the purposes of expanding the envelope of safe operation of the reactor. Acoustic data was collected and back-propagation neural network trained to recognize boiling under a variety of conditions. One hundred percent accuracy was achieved for the limited range of experiments performed.

PIPER, George E., Assistant Professor, and E. Eugene MITCHELL, Professor, "VISSIM: An Affordable Graphical Simulation Tool for Dynamic Systems," *Computers in Education Journal*, October 1995.

VISSIM is an affordable simulation tool that features a graphical user interface to model linear and nonlinear dynamic systems. This paper discusses how VISSIM's graphical modeling environment reduces the time it takes to build and simulate models, and how it provides a more intuitive way to describe them. Examples are provided to illustrate VISSIM's range of application, from simple differential equations to a complex practical models.

URBACH, Herman B., Richard W. Garman, Donald T. Knauss, Jerry W. WATTS, Associate Professor, Terrence E. DWAN, Professor, E. Eugene MITCHELL, Professor, Howes, Cory, "A Steam-Augmented Gas Turbine with Reheat Combustor for Surface Ships", *Naval Engineers Journal*, May 1994, pp 41-51.

The steam-augmented gas turbine (SAGT) concept has attracted attention because of its benign level of  $\text{NO}_x$  emission, its increased fuel efficiency, and significant, cost-effective increments of output power, particularly when moisture injection is increased to levels approaching 50% of air flow. Such high levels of moisture consumption distinguish the SAGT engine from commercial steam-injected gas turbines where steam flow may be less than 15% of air flow. At the

high 50% levels, the SAGT burner would operate near stoichiometric combustion ratios with specific powers exceeding 570 HP-sec/lb.

By adding a low pressure reheat combustor (2 combustors total) thermal efficiencies near 43% are achieved. Tabular and graphical simulation data shows the maximum efficiency to occur at part power, near the cruising speed for Navy ships.

WATTS, Jerry W., Associate Professor, E. Eugene MITCHELL, Professor, Terrence E. DWAN, Associate Professor, Herman B. Urbach, and Richard W. Garman, "Improved Efficiency and Power Burst in a Gas Turbine Engine." *Proceedings of the IASTED International Conference on Modeling and Simulation*, August 1995, pp 171-172.

The steam-augmented gas turbine (SAGT) engine has three important advantages over other gas turbine engines. (1) There are significantly lower  $\text{No}_x$  emissions. (2) Efficiency is improved over that of regenerated engines. (3) There is a power burst capability that is not achievable with other power augmenting schemes, such as turbo-charging. At steam injection levels of about 0.5 lbm steam per lbm of compressed air the specific power of the SAGT engine increases to 580 hp-sec/lbm air which is about three times that of the simple cycle and the intercooled-regenerated (ICR) gas turbine engines investigated in this study. Turbo-charging the ICR engine up to a pressure ratio of 2.0 still only produced a specific power of 302 hp-sec/lbm of air. The rather large quantities of pure water needed for the SAGT engine are provided by reverse-osmosis desalination unit.

WICK, Carl E., Assistant Professor, Murray H. Loew and Joseph Kurantsin-Mills, "Using Modeling and Fuzzy Logic to Detect and Track Microvessels in Conjunctiva Images." *Proceedings, Second IEEE Workshop on Applications of Computer Vision*, December 1994, pp 114-120.

This article discusses our efforts to find a reliable method to automate the analysis of blood vessels found in the human conjunctiva membrane, commonly called the "white of the eye". We have been successful in producing a model that accurately describes signals produced from film records. The work is now being extended to use this information to automate detection and classification schemes. Fuzzy logic based algorithms have proved to be good performers and are reported on in this paper.

WICK, Carl E., "Using GALS in an Introductory Digital Design Course." *ASEE Computers in Education Journal*, Volume IV, No 4, October-December 1994, pp 2-7.

This paper reports on the positive experiences of using a new technology component, the Generic Array Logic (GAL) device in an introductory digital engineering course at the U.S. Naval Academy. This device allows beginning students to produce practical digital circuits with less error-prone wiring, allowing them to spend

more successful time on design issues in the laboratory. The device and course content are discussed.

## Presentations

DWAN, Terrence E., Professor and Jerry W. Watts, Associate Professor, "A Steam-Augmented Gas Turbine Model," The International Association of Science and Technology for Development (IASTED) Conference on Modeling and Simulation, Pittsburgh, Pennsylvania, 27-29 April 1995.

PIPER, George E., Assistant Professor, "Animated Space Motion Simulator," The International Association of Science and Technology for Development (IASTED) Conference on Modeling and Simulation, Pittsburgh, Pennsylvania, 27-29 April 1995.

WATTS, Jerry W., Associate Professor, "Improved Efficiency and Power Burst in a Gas Turbine Engine," The International Association of Science and Technology for Development (IASTED) Conference on Modeling and Simulation, Pittsburgh, Pennsylvania, 2-4 May 1994.

WICK, Carl E., Assistant Professor, "Using Modeling and Fuzzy Logic to Detect and Track Microvessels in Conjunctiva Images," Second IEEE Workshop on Applications of Computer Vision, Sarasota, Florida, 6 December 1994.

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**Division of  
Humanities and Social Sciences**

# Economics

Professor Rae Jean B. Goodman  
Chair

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During the past year, the research efforts by the faculty of the Economics Department have been quite successful and covered diverse topics. The members of the department have produced six publications and given six presentations at conferences. The diversity is represented by Assistant Professor Thierfelder's research using computable general equilibrium models to Professor Bowman's research on the cost of producing career officers in various specialties from a variety of accession sources to Professor Morris' work on Say's Law. The research areas represent the strengths of the Economics Department in defense economics, international economics, and fundamental economic theory.

Several faculty members' research efforts were sponsored by the Department of Defense and the Naval Academy. Professor Bowman's research on the cost effectiveness of the Naval Academy as an officer source is one of the original research efforts sponsored by the Office of Institutional Research. Professors Fredland and Little are completing the editing of the proceedings of the conference on the All-Volunteer Force After Twenty Years. Assistant Professor Thierfelder extends the applications of the computable general equilibrium models to analyze migration patterns, labor market policies, and trade policies in countries ranging from Bangladesh to Mexico.

The independent research performed by faculty members holds great promise for future conference presentations and refereed publications. Assistant Professor Getter's research on credit availability in the 1980s provides insights into the economic recovery of the 1980s and 1990s and into the risk analysis performed by creditors. Professor Morris' analysis of the contributions of Jean Baptiste Say within the

context of the development of economic theory enhances the classroom experience of midshipmen in the History of Economic Thought. Assistant Professor Thierfelder continues to expand her interest in international economics. The research on incentives and performance on the Major Field Achievement Test in Economics underscores the potential impact of incentives on student behavior.

The research completed by midshipmen reflect the diversity in interests of both the faculty and midshipmen. Jay West's research on the racial difference of the effect military experience (veterans status) has on wages earned in the civilian labor force supported previous research that indicated that veterans earn less. The honors research project of James Dillon examined the political and economic determinants of prices in the cable T.V. industry. The results emphasized that political influences are stronger than economic determinants and, thus, regulation should shift focus from price regulation to one creating a competitive environment. Performance and the pay of professional baseball players was the subject of research performed by Douglas Campbell for his honors thesis. The conclusion is that the salary increases of baseball players is based on the increased revenue the players generate based on on-field performance.

Research is a valuable tool to bring fresh ideas and results to the midshipmen in the classroom, to extend the academic reputation of the Department and the Academy, and to make contributions to the understanding of economics. To maintain professional involvement of the faculty and enrich the classroom environment for midshipmen, faculty members require continued support to pursue research projects of interest.

## **Sponsored Research**

### **Cost Effectiveness of the United States Naval Academy**

Researcher: Professor William R. Bowman

Sponsor: Office of Institutional Research

The study analyzes the population of Navy Officers at consecutive selection boards between two periods: 1980-1989 and 1985-1994. The analysis attempts to explain retention behavior of a cohort of officers from: 01 through 04; 04 through 05; and 05 through 06 boards. The study also analyzes the promotion pattern

of these 3 cohorts to 04, 05, and 06 grades.

The emphasis of the study is the estimation of greater retention and promotion propensities of United States Naval Academy graduates relative to those from ROTC and OCS accession sources.

### **A Military of Volunteers: Yesterday, Today and Tomorrow**

Researchers: Professor J. Eric Fredland  
and Professor Roger D. Little

Sponsor: Department of Defense

In September, 1993, the Naval Academy hosted a major conference on the 20th anniversary of the all-volunteer force. The conference, which brought together researchers and practitioners, was jointly sponsored by the Academy and Department of Defense. The papers presented at the conference are to be published as a

volume of conference proceedings, edited by J. Eric Fredland and Roger D. Little of the United States Naval Academy, and C.L. Gilroy and W.S. Sellman of the Department of Defense. A publishing contract has been signed and conference proceedings are in the editing process.

### **The Differential Effects of Foreign and Domestic Takeovers on U.S. Firms**

Researcher: Assistant Professor Ksenia M. Kulchycky

Sponsor: Naval Academy Research Council

This paper is an analysis of the effects of foreign takeovers of U.S. firms on the operations of those firms. The recent growth in foreign takeovers of American firms has led to many anxious comments in the press, various proposals for registration provisions, and other legislative proposals for restrictions. Fear of foreign takeovers includes anxiety over excessive foreign influence on our economic and political system, foreign

acquisition of proprietary technology and shifting of research and development investment from the U.S., thereby eroding U.S. competitiveness, reducing employment and skill levels of U.S. workers, and transferring of high-tech, high value-added, components of production away from the U.S. Despite the concern regarding foreign takeovers, there has been little research done on their effects.

## **Labor Market Policies, Trade Liberalization and the Distribution of Income in Bangladesh**

Researchers: Assistant Professor Karen E. Thierfelder  
(with Shantayanan Devarajan, The World Bank and Hafez Ghanem, The World Bank)  
Sponsor: The World Bank, Policy Research Division, Public Economics

Governments in low-wage developing countries attempt to maintain incomes for certain labor groups through policies such as severance pay and minimum wage requirements. These labor market distortions act as "safety-nets" when more precise targeting is infeasible. The resulting labor market structure can impede the efficient allocations of resources following structural adjustment, restricting growth. This research examines the effects of labor market rigidities using a general equilibrium model of Bangladesh. This research shows that the income distribution following trade liberalization changes dramatically when there are safety nets. The poorest households must bear the burden of adjustment when there are labor market

policies to benefit the urban formals. In the absence of such labor policies, the poorest households experience a real wage increase following trade liberalization, suggesting the labor market reforms should accompany trade liberalization in low-income countries like Bangladesh. More generally, the labor policies which apply directly to a small percentage of the total labor force have a strong effect on other labor groups due to the linkages in the economy. This suggests that policy analysts should incorporate labor market distortions when evaluating the effects of trade liberalizations. This research is complete and is being prepared to be submitted to the Journal of Labor Economics.

## **Migration, Prices and Wages in a North American Free Trade Agreement**

Researcher: Assistant Professor Karen E. Thierfelder (with Mary Burfisher, U.S. Department of Agriculture and Sherman Robinson, International Food Policy Research Institute)  
Sponsor: Naval Academy Research Council

This research examines wage changes that can accompany trade liberalization between the United States and Mexico under the North American Free Trade Agreement (NAFTA). There are two forces at work: indirect links between prices and wages as described in the Stolper-Samuelson theorem, and direct effects of migration on labor supplies in the two countries. Much of the debate over potential wage changes reflects views about the links between output prices and factor prices as described in the Stolper-Samuelson theorem. However, one needs an empirical

model with both price changes and migration to determine which wage effect dominates following trade liberalization. Using an 11-sector computable general equilibrium (CGE) model which includes the United States, Mexico, and the rest of the world, we find that migration effects generally dominate Stolper-Samuelson effects on wages. This paper was an invited submission at the International Agricultural Association Meetings in Harare, Zimbabwe. The research is complete and will appear as an IAAE Occasional Paper.

## **Policy Interaction Between Countries: Evidence from a CGE Model of the United States and Mexico**

Researcher: Assistant Professor Karen E. Thierfelder (with Mary Burfisher, U.S. Department of Agriculture and Sherman Robinson, International Food Policy Research Institute)  
Sponsor: Naval Academy Research Council

Theoretical models have shown that a country's domestic policies are linked to its trade policies. This research extends the analysis to examine policy interaction between countries. A twenty-nine sector CGE model of the U.S. and Mexico with trade and migration linkages was used. There are twenty-one agricultural sectors and an explicit modeling of agricultural policies. Agriculture is an important source

of potential migrants in Mexico, since it employs a large proportion of the labor force. First, the interaction between farm support programs in the two countries is examined. The research shows that Mexico's quota policies can be viewed as a response to the U.S. deficiency payments program. As the deficiency payments are eliminated, the tariff equivalent of the quota declines and becomes negative. Also,

eliminating the quota in Mexico increases imports from the U.S. but also increases migration from Mexico to the U.S. The decline in U.S. rural wage reduces farm income despite intervention in the product market to support farmers. Next, the interaction between exchange rate policy in Mexico and potential trade retaliation in the U.S. is examined. When Mexico devalues, there is potential for increased migration to the U.S. as workers see the peso value of dollar wages increase. However, there are also potential employment gains in Mexico as structural adjustment leads to export

growth and import substitution. If the U.S. retaliates with tariffs in selected sectors, such as agriculture, it will worsen the structural adjustment process in Mexico and encourage further migration to the U.S..

This research is almost complete and will be sent to the American Journal of Agricultural Economics to consider for publication. The abstract has been submitted to the American Economics Association Meetings, January 1996 and the Sixth International CGE Modeling Conference, October 1995.

## **Trade Reform and Labor Unions: A General-Equilibrium Analysis Applied to Bangladesh and Indonesia**

Researcher: Assistant Professor Karen E. Thierfelder  
(with Shantayanan Devarajan, The World Bank and Hafez Ghanem, The World Bank)  
Sponsor: The World Bank, World Development Report

How does the presence of labor unions affect the outcome of trade reforms in developing countries? On the one hand, labor unions may impede the reallocation of labor which is necessary to reap the gains of trade liberalization. On the other hand, increased import competition may undermine the power of labor unions, thereby accentuating the gains from trade reform. In this paper, these issues are investigated by simulating different types of unions in a family of general-equilibrium models designed to highlight different aspects of the trade-labor link. First, we contrast the roles of "passive" and "aggressive" unions in a stylized, two-sector model. We find that the presence of either type of unions increases the welfare gains from trade liberalization, as the trade reforms force the unionized sector to contract, reducing the distortion in the labor market. Furthermore, with an aggressive union, there is an additional gain, as the surplus workers are drawn

into the productive labor force when the unionized sector contracts. The next step is to test the results of this stylized model against data from two countries where labor unions and trade liberalization are important policy issues. In Bangladesh, where there is heavy trade protection in the unionized sectors we ask whether the welfare gains from trade liberalization are in fact greater than otherwise predicted. In Indonesia, where there are no unions and low import tariffs, we examine whether a policy of allowing unions is superior to introducing a minimum wage, especially in terms of rewarding workers and preserving the economy's flexibility. This research is in process; we will submit it to the World Bank Economic Review. The abstract has been submitted to the National Bureau of Economic Research (NBER) Summer meetings, 1995 and to the Sixth International CGE Modeling Conference, October 1995.

## **Independent Research**

### **Did Lenders Make It Easier For Households to Obtain Credit During the 1980s?**

Researcher: Assistant Professor Darryl E. Getter

Both aggregate and survey data suggest that the level of household indebtedness rose rapidly during the 1980s. Given the developments in financial intermediation, We test whether credit constraints were relaxed and investigate the possibility of a change in lending

criteria, using data from the 1983 and 1989 Surveys of Consumer Finances. The finding suggest that lenders were better able to assess risks for marginal populations, tending to increase the access to credit of households with favorable economic characteristics.

## **Has It Become Easier for U.S. Households to Obtain Credit?**

Researcher: Assistant Professor Darryl E. Getter

Much of the recent consumption literature has used survey data to test for the existence of liquidity constraints. However, both aggregate and survey data suggest that the level of household indebtedness rose rapidly during the 1980s. Given the rise in household indebtedness, data from the 1983 and 1989 Surveys of

Consumer Finances are used to see if fewer households by 1989 are reporting themselves as having difficulty obtaining credit. The findings suggest that low income households, younger households, and non-white households may have had an easier time getting credit by 1989.

## **Examination Performance and Incentives**

Researchers: Professor Rae Jean B. Goodman and Associate Professor Thomas A. Zak

The fundamental hypothesis is that providing a monetary incentive stimulates student performance on a standardized exam. The data used for the analysis are the performances of first class economics majors on the Major Field Achievement Test for the 1989-1991 period. The experimental setup was to divide the class into separate classrooms matching the academic quality of the two rooms by QPR rank. As students entered the "incentive" room they were given a memorandum which informed them that there were monetary prizes for the top three performers by four QPR groupings.

The students in the other room received the same memorandum as they exited the exam. The empirical analysis tests the hypothesis while holding ability measures constant; the ability measures include economics QPR, overall QPR, SAT scores, performance in intermediate macroeconomics and microeconomics courses, numbers of economics courses completed, etc. The analysis has not been completed; however, the plan is to complete the research during the intersessional period.

## **The Significance of Say's Law in the History of Economics**

Researcher: Professor Clair Morris

Jean Baptiste Say was a late 18th to early 19th century French economist who is noted for his contributions to Classical economic doctrine. His notion that "Supply creates its own Demand" became the foundation for the Classical position on the appropriate role of government in a free enterprise capitalistic society. The purpose of this study is to address the following questions: what is the principal tenet of Say's Law? in what ways does this Law differ from Say's Identity and Say's Equality? why did Keynes reject this Law? what

are the policy implications of this Law? in what ways is this Law related to the New Classical and the New Keynesian models? Say's publications and the secondary literature that has been published on his work will be reviewed for insights into the answers to these questions. This study began in the fall of 1994 and is expected to be published in 1996 in the Encyclopedia of Keynesian Economics which is being edited by Tom Cate, David Collander, and Geoffrey Harcourt.

## **How Strong are the Links between Trade Policy and Factor Returns? Evidence from a Stylized CGE Model**

Researcher: Assistant Professor Karen E. Thierfelder  
(with Sherman Robinson, International Food Policy Research Institute)

Often, people cite the Stolper-Samuelson and the factor price equalization theorems to describe the changes in wages following trade reform. In the debate over the North American Free Trade Agreement (NAFTA), for example, there was concern that U.S. unskilled wages would decline dramatically if tariffs against Mexican imports were eliminated. This assessment was based on

the Stolper-Samuelson theorem -- as the price of the unskilled labor intensive good declines, the real return to unskilled labor will decline. While important theoretically, a crucial question for the policy debate is, how relevant are these theorems empirically? A number of factors mitigate against the effectiveness of the Stolper-Samuelson and the factor price equalization



theorems. First, there are technology differences between countries, violating an assumption of the factor price equalization theorem. Second, intermediate goods in production make the differences in capital-labor ratios between commodities less extreme. This dampens the expected factor price response to a price shock. Finally, there are other distortions in the economy, creating second best effects. Using a stylized multi-country computable general equilibrium (CGE) model, we explore the strengths of links between factor

returns and output prices. We focus on the features of an empirical model that dampen the linkages found in the theoretical model -- technology differences, intermediate goods, and other distortions. We find that the Stolper-Samuelson effects exist, but are weak. Furthermore, we find that empirically, the factor price equalization does not hold.

This abstract has been submitted to the Sixth International CGE Modeling Conference, October 1995. The research is in the preliminary stages.

## **The Impact of the Mexican Crisis on Trade, Agriculture, and Migration**

Researcher: Assistant Professor Karen E. Thierfelder (with Mary Burfisher, U.S. Department of Agriculture, and Sherman Robinson, International Food Policy Research Institute)

For the past few years, Mexico has benefitted from large inflows of short-term foreign capital. It has been widely recognized that these large annual flows were unsustainable in the longer run. The question was not whether there would be a real depreciation, but how smoothly and over what time period. Given the precipitous depreciation in December 1994, the question now is how will the economy adjust? Will Mexico have a "hard landing" similar to their experience in the early 1980's, with major unemployment, declines in capacity utilization, and increased migration to the U.S.? Or, with appropriate policies, can they achieve a "soft landing," making the needed adjustments without serious disruption of the economy or increased migration? In this paper, we analyze the role of Mexican and U.S. policies in supporting Mexico to achieve a soft landing. We utilize a computable general equilibrium trade model of the U.S. and Mexico to compare the effects of the Mexican

crisis under alternative policy scenarios. We find that the structural adjustment process can be seen as an acceleration of beneficial trends that were occurring under NAFTA. Both the U.S. and Mexico gain from increased trade in both directions, and migration pressure is reduced. Agriculture plays a key role in Mexico's structural adjustment. Export growth in relatively high productivity sectors such as fruits and vegetables will "pull" resources, especially irrigated land, out of corn and beans. Agriculture gains from the depreciation and structural adjustment, increasing labor demand and slowing rural-urban migration. In turn, this reduces the pressures in Mexico's urban labor markets and reduces migration pressure to the U.S. This research is in the final stages. It is an invited paper in the conference, "Towards a Continental Agricultural Policy" of the North American Agricultural Policy Research Consortium.

## **The Impact of the Mexican Depreciation on Trade and Migration**

Researcher: Assistant Professor Karen E. Thierfelder (with Mary Burfisher, U.S. Department of Agriculture, Raul Hinojosa, The International Development Bank, and Sherman Robinson, International Food Policy Research Institute)

This is an analysis of the impact of the Mexican depreciation and structural adjustment process on trade and economic performance in the two economies, and on labor migration. The analysis uses a two-country 29-sector trade model of Mexico and the U.S. To analyze the impact of structural adjustment on migration, we repeat the five experiments under two migration scenarios. In the first, potential migrants are assumed to compare wages in the unskilled rural and urban labor markets in the two countries in a common currency, migrating if the wage differential widens. In this scenario, migration is sensitive to changes in local real wages and is very sensitive to changes in the exchange rate, since any depreciation immediately

generates a wage differential in a common currency. In the second scenario, potential migrants are assumed to look at real wage changes in local currency, migrating only if the real wage in the U.S. in dollars grows faster than the real wage in Mexico in pesos. We find that if structural adjustment in Mexico is successful, the changes in sectoral trade and production will actually lessen migration pressure. Structural adjustment necessarily involves major increases in Mexican exports to the U.S. If such increases are met with resistance and protectionist pressure from U.S. producers and agricultural interests, the net effect will be to endanger the recovery and further destabilize the Mexican economy.

## **Trade and Labor Market Behavior in Computable General Equilibrium Models**

Researcher: Assistant Professor Karen E. Thierfelder  
(with Clinton R. Shiells, The International Monetary Fund)

The base data needed to construct CGE models usually show sectoral wage differentials, which pose a challenge for modeling based on perfectly competitive labor markets. The underlying behavior which generates the observed wage differentials can crucially influence changes in resource allocation and welfare resulting from domestic tax and tariff changes. In fact, depending on the behavior in the labor market and the pattern of protection, trade liberalization can actually reduce welfare, contradicting the results obtained using a model with neoclassical labor markets and no other distortions. To investigate these issues, we consider three possible explanations for sectoral wage differences—sector specific productivity differences, the

presence of an efficiency wage sector in which producers pay a wage premium to eliminate shirking, and the presence of a union in one sector. We then construct a stylized, two-sector, CGE model and incorporate each of the three different interpretations of the wage differentials. We find that when the wage differentials are endogenous, policies that expand the high-wage sector also exacerbate the labor market distortion as the wage differentials increase. This dampens the welfare gains that otherwise arise when wage differentials are assumed to be exogenous. This research is complete and will be published in Applied Methods for Trade Policy Analysis Joseph F. Francois and Kenneth A. Reinert eds.

## **Research Course Projects**

### **Military Experience and Civilian Wages: Racial Differences**

Researcher: Midshipman 1/C Jay West, USN  
Adviser: Professor Roger D. Little

Recent research on the effect of veteran status on civilian earnings, in contrast to earlier findings, tends to support the proposition that veterans earn less, other things equal. This research replicated a study by R. Bryant and A. Wilhite ("Military Experience and Training Effects on Civilian Wages," Applied Economics, 1990, pp. 69-81) and attempted to develop their study by including additional variables, namely racial interactions and failure to complete initial service obligation. Indications are that military service

adds to the human capital of black servicemen in general, but not to those who served in the Navy. Those who quit before the end of their service obligation earn about fifteen percent less in their civilian jobs than those who completed their tour, suggesting characteristics which lead to failure in the military are carried over to the civilian sector. The findings are promising enough that further refinement of the data could lead to a comment on the Bryant-Wilhite paper.

### **Price Determination in the Cable TV Industry: A Combination of Political and Economic Forces**

Researcher: Midshipman 1/C James W. Dillon, USN  
Adviser: Assistant Professor Karen E. Thierfelder

This paper discusses the political and economic forces that affect price determination in the cable T.V. industry. Included are background discussions on previous work done on the subject, current legislation governing the industry, the bidding method, and

political influences. An econometric analysis is included to measure the effects of each force in the industry. The results of this paper show that although economic factors influence prices in the cable industry, their effect is weak compared to the political influences

present. We conclude that regulation of the industry needs to shift its focus from direct price regulation to a type of regulation designed to enhance competition rather than interfere with it.

This research is Midshipman James Dillon's honors project. The intent is to revise the paper for submission to a journal.

## Performance and Pay in Baseball

Researcher: Midshipman 1/C Douglas C. Campbell, USN

Adviser: Professor Thomas A. Zak

Are professional baseball players overpaid? This is a frequently asked question certain to generate significant disagreement among sports fans. This paper develops a theoretical model of player compensation, and empirically compares estimated "worth" to actual compensation. A profit maximizing team will pay a player an amount up to the revenue that player is expected to generate for the team (the player's marginal revenue product). An individual player's marginal revenue product depends upon several things: the extent to which a player's on-field performance contributes to winning, additional revenue that the team earns from additional wins, and idiosyncratic player characteristics that attract fans independent of measurable performance - charisma. This paper uses all three elements to estimate the marginal revenue product for individual major league baseball players, then compares the

estimated values to actual salaries.

A model of player productivity using a set of detailed measures of offensive and defensive skills is estimated. Once the production function for wins is estimated, the research estimates a revenue function for major league teams with wins and "charisma" as two of the explanatory variables. Thus, one can calculate how many additional wins to attribute to a player (based on on-field performance) and then calculate how much additional revenue a given player generates for his team. The empirical results indicate that, in general, major league baseball players are not overpaid. While some players are overpaid, others are underpaid relative to the revenue that they generate for the team. Salary increases in the past decade are primarily attributable to rising marginal revenue product over that time.

## Publications

BOWMAN, William R., Professor, "Impacts of Employment Training for Disadvantaged Youth," in *Employment Opportunities for Youth*, Report prepared for the National Commission for Employment Policy, February 1995.

This study surveys the employment history of youth in American, with special emphasis on state and federal training programs. Chapter 5 contains empirical results of training intervention for a 10 state sample of male and female youth aged 18 to 21. Results indicate greater impacts for females than males, and impacts that decline significantly over time for all terminees.

LITTLE, Roger D., Professor, and Mark J. Eitelberg, "Influential Elites and the American Military After the Cold War," in Don M. Snider and Miranda Carlton-Carew, eds., *U.S. Civil-Military Relations: Crisis or Transition?* Washington, D.C.: Center for Strategic and International Studies, Westview Press, 1995.

This paper explores influential elites whose actions can affect American civil-military relations during the post-Cold War era. It focuses on the widening gap between

the military and groups whose behavior and attitudes can disproportionately affect the defense establishment. Several common themes emerge. The military is alienated from the media. There is expanding military influence over government decisions affecting foreign, defense, economic, and social policy. While the military enjoys widespread support, support has been shrinking since the Gulf War and may decline further as the force shrinks, defense-related industry and research withers, bases are consolidated, and lines of contact with local communities are reduced.

Baby boomers are increasingly on the march as America's new men and women of mark. Because few who are ascending to elite status have military service, there is a void of personal experience with defense matters. The fractured relations between the military and the Clinton administration may be further amplified in Congress, where support for the military may decline as members who are veterans shrinks. Although the trends are not clear, voting data suggest that non-veterans are less "pro-defense," and that Congress is destined to become a body lacking in the sense of defense nuance and perspective of its predecessors.

MORRIS, Clair E., Professor, "Review of Strategic Factors in Nineteenth Century American Economic History: A Volume to Honor Robert W. Fogel," ed. by Claudia Goldin and Hugh Rochoff, (Chicago: University of Chicago Press for NBER, 1992), in the *Eastern Economic Journal*, V.20, No.2, Spring 1994, pp. 236-238.

This review praised the editors for bringing together a number of outstanding studies by former students of Robert W. Fogel, who shared the Nobel Prize in Economics in 1993. Fogel and his students have had an enormous impact on economic history, and it was altogether fitting that he should be so honored. This book included studies that were representative of the contributions that he has made over a long career. The influence of Fogel's insistence on a methodology that captured quantitative measurement and analysis was prominently displayed in all these studies. Most of the works will find their way on readings lists for graduate courses in economic history, and will provide many insights for additional research.

THIERFELDER, Karen, Assistant Professor (with Clinton R. Shiells, The International Monetary Fund), "Trade and Labor Market Behavior in Computable General Equilibrium Models," in Joseph F. Francois and Kenneth A. Reinert eds., *Applied Methods for Trade Policy Analysis*, Cambridge University Press, 1995.

The base data needed to construct computable general equilibrium (CGE) models usually show sectoral wage differentials, which pose a challenge for modeling based on perfectly competitive labor markets. The underlying behavior which generates the observed wage differentials can crucially influence changes in resource allocation and welfare resulting from domestic tax and tariff changes. In fact, depending on the behavior in the labor market and the pattern of protection, trade liberalization can actually reduce welfare, contradicting the results obtained using a model with neoclassical labor markets and no other distortions. To investigate these issues, we consider three possible explanations for sectoral wage differences--sector specific productivity differences, the presence of an efficiency wage sector in which producers pay a wage premium to eliminate

shirking, and the presence of a union in one sector. We then construct a stylized, two-sector, CGE model and incorporate each of the three different interpretations of the wage differentials. We find that when the wage differentials are endogenous, policies that expand the high-wage sector also exacerbate the labor market distortion as the wage differentials increase. This dampens the welfare gains that otherwise arise when wage differentials are assumed to be exogenous.

THIERFELDER, Karen, Assistant Professor (with Mary Burfisher, U.S. Department of Agriculture, Raul Hinojosa, The International Development Bank, and Sherman Robinson, International Food Policy Research Institute) "The Impact of the Mexican Depreciation on Trade and Migration" Research Brief, International Food Policy Research Institute, Washington, D.C., February 1995.

This is an analysis of the impact of the Mexican depreciation and structural adjustment process on trade and economic performance in the two economies, and on labor migration. The analysis uses a two-country 29-sector trade model of Mexico and the U.S. To analyze the impact of structural adjustment on migration, we repeat the five experiments under two migration scenarios. In the first, potential migrants are assumed to compare wages in the unskilled rural and urban labor markets in the two countries in a common currency, migrating if the wage differential widens. In this scenario, migration is sensitive to changes in local real wages and is very sensitive to changes in the exchange rate, since any depreciation immediately generates a wage differential in a common currency. In the second scenario, potential migrants are assumed to look at real wage changes in local currency, migrating only if the real wage in the U.S. in dollars grows faster than the real wage in Mexico in pesos. We find that if structural adjustment in Mexico is successful, the changes in sectoral trade and production will actually lessen migration pressure. Structural adjustment necessarily involves major increases in Mexican exports to the U.S. If such increases are met with resistance and protectionist pressure from U.S. producers and agricultural interests, the net effect will be to endanger the recovery and further destabilize the Mexican economy.

## Presentations

GIBB, Arthur, Associate Professor, "A Traditional Macro-Micro Treatment for Non-Majors and Majors," Eastern Economics Association annual meeting, New York City, NY, 18 March 1995.

GIBB, Arthur, Associate Professor, "Filling the Void; Non-Majors As the Other Half of the Undergraduate Program," Eastern Economics Association annual meeting, New York City, NY, 17 March 1995.

GOODMAN, Rae Jean B., Professor, "Examination Performance and Incentives," presented at the Economics Department Seminar, Davidson College, Davidson, NC, 28 February 1995.

LITTLE, Roger D., Professor and Mark J. Eitelberg, "The Changing Values of Influential Elites on the U.S. and Implications for the Military," Conference on U.S. Civil-Military Relations, Carlisle Barracks, PA, 13 September 1994.

THIERFELDER, Karen E., Assistant Professor, "Labor Market Regulation, Trade Liberalization and the Distribution of Income in Bangladesh," presented at the Fifth International CGE Modeling Conference, Waterloo, Ontario, Canada, October 28, 1994.

THIERFELDER, Karen E., Assistant Professor, "Labor Market Regulation, Trade Liberalization and the Distribution of Income in Bangladesh," presented at the World Development Report Seminar Series, September 26, 1994.

THIERFELDER, Karen E., Assistant Professor, "Labor

Market Policies, Structural Adjustment and the Distribution of Income in Bangladesh," presented at the Western Economic Association Meetings, Vancouver, British Columbia, Canada, July 2, 1994.

THIERFELDER, Karen, Assistant Professor (with Sherman Robinson, International Food Policy Research Institute, and Mary Burfisher, U.S. Department of Agriculture), "Migration, Prices and Wages in a North American Free Trade Agreement" (with Mary Burfisher, U.S. Department of Agriculture and Sherman Robinson, International Food Policy Research Institute) IAAE Occasional Paper No. 7. Gower Publishing Co., Hants, UK, **forthcoming**.

In this paper, we examine wage changes that can accompany trade liberalization between the United States and Mexico under a North American Free Trade Agreement (NAFTA). There are two forces at work: (1) indirect links between prices and wages as described in the Stolper-Samuelson theorem, and (2) direct effects of migration on labor supplies in the two countries. Much of the debate over potential wage changes reflects views about the links between output prices and factor prices as described in the Stolper-Samuelson theorem. However, one needs an empirical model with both price changes and migration to determine which wage effect dominates following trade liberalization. Using an 11-sector CGE model which includes the United States, Mexico, and the rest of the world, we find that migration effects generally dominate Stolper-Samuelson effects on wages.

# English

Professor Michael P. Parker  
Chair

The highlight of the research year for the English Department was the publication of two significant books: The Cultural World in Beowulf, by Professor John Hill; and Empty Nest, Full Life, by Associate Professor Anne Marie Drew. Employing an anthropological approach, Professor Hill's monograph examines the social systems of exchange and feud in the greatest of Old English poems; in doing so, he opens up a whole new realm for critical investigation. This book will be the one that critics return to in any discussion of the social world of Beowulf over the next generation. Professor Drew's book explores how women respond to the maturation and departure of their children in what has come to be known as "the empty-nest syndrome"; weaving personal experience with accounts of other women, she points to ways of transforming loss and sadness into new opportunities for growth. Two other faculty members had monographs accepted by major university presses over the past year: the University of Delaware Press plans to publish Henry Fielding's Novels and the Classical Tradition by Assistant Professor Nancy A. Mace; and Oxford University Press has accepted Postcards from the Trenches: Negotiating the Space between Modernism and the First World War by Assistant Professor Allyson Booth.

Other members of the department have been similarly productive during the 1994-95 academic year. Members of the department have published over 20 articles on topics ranging from the Breton lai to modern dance, from Aztec religious poems to the sea chantey.

English Department faculty also delivered over 20 papers at scholarly meetings, including the annual conventions of the most prestigious professional organizations. Three faculty members were awarded Naval Academy Research Council Grants: Assistant Professor Allyson Booth, Associate Professor Bruce E. Fleming, and Assistant Professor Nancy A. Mace.

Midshipman research this year was represented by Midshipman First Class Caroline Magee's Trident Project, "The Characterization of the African-American Male in Fiction by African-American Women," directed by Professor Fred M. Fetrow. Midshipman Magee argues that a survey of contemporary African-American fiction suggests that the literature is not anti-male but, to the contrary, extraordinarily sympathetic to the unique problems confronted by African-American men. In March the Trident Committee approved a midshipman proposal for the 1995-96 academic year: Midshipman Jay Mihal's "A Critical Edition of the Arthurian Poems of Charles Williams," which will be directed by Professors David O. Tomlinson and John C. Wooten.

The paradigm that this work reflects--self-generated efforts supported by institutional funding that culminate in published work or conference papers--keeps the department vital and effective in its support of the Naval Academy mission. In the end, all of our research and publications focus ultimately on one objective: the very best education for midshipmen.

## Sponsored Research

### Postcards from the Trenches: Negotiating the Space Between Modernism and the First World War

Researcher: Assistant Professor Allyson Booth  
Sponsor: Naval Academy Research Council (OM&N)

The researcher has a book contract from Oxford University Press and will be working on final revisions to the manuscript this summer. The book uses the relationships between civilians and soldiers to structure

an examination of ways in which modernism responded to and registered the perceptual dislocations of World War I.

## **A Critical Study of Mary Gordon's Fiction**

Researcher: Associate Professor Eileen Johnston  
Sponsor: Naval Academy Research Council

This project is a book-length study of the thought and work of Mary Gordon, a highly acclaimed contemporary American writer. This book traces Gordon's development as a novelist and short story writer from several perspectives: 1) Her esthetic, religious, social, and political ideas articulated in her many essays, reviews, and interviews; 2) the Irish

immigrant tradition in America; 3) the Christian tradition, especially its Roman Catholic dimension; 4) the tradition of fiction by and about women; 5) the perspective of ideas about houses, domestic spaces, and shelter, a crucial symbolic complex pervasive throughout Gordon's writing. This project is fully under way; a partial draft of the manuscript is available.

## **Rocking the Cradle of the Navy: The Naval Academy Career of William Oliver Stevens**

Researcher: Professor Michael P. Parker  
Sponsor: Naval Academy Research Council (1987)

Anyone with even the slightest interest in naval history knows of Alfred Thayer Mahan and the tremendous influence he exerted upon the modernization of the U. S. Navy at the turn of the century. Largely forgotten, however, are the men who transmitted the ideas of Mahan to naval officers and who revolutionized the teaching of naval history--the civilian professors of the Naval Academy's old English Department. Preeminent among this new generation of naval historians was William Oliver Stevens (1878-1955). The author of 47 books during the course of a long life, he emerged during the second decade of the twentieth century as the most authoritative and imaginative of the many civilian writers of naval affairs. His History of Sea Power (1920), coauthored by Allan Westcott, was the first

textbook to survey the influence of seapower from the ancient world to modern times; it remained a required text at the Academy for thirty-five years. Stevens's brilliant career at the Academy came to an abrupt end in 1924 when the superintendent, Rear Admiral Henry B. Wilson, refused to renew his contract. Officially, Stevens was let go for reasons of economy; the full story, in fact, is a complex fabric that weaves together naval politics, academic freedom, family feuds, and the recurrent controversy over the place of the civilian faculty at the Academy. An article on this subject has been accepted by Naval History for publication.

## **Independent Research**

### **Exploring the Baroque**

Researcher: Associate Professor Marlene Browne

This project explores the complex interrelationships between music, architecture, and literature during the Baroque era. The research seeks to examine the extent to which the music of the period is rooted in architectural and literary theory and practice; to that

end, she has done extensive reading in musical criticism and biography, focusing in particular on what composers like Vivaldi, Handel, Corelli, and Telemann wrote about their music and the aesthetic that animates it.

### **History in the Works of Afro-American Poets**

Researcher: Associate Professor Marlene Browne

This project is an examination of several contemporary African-American poets with a special emphasis on the

use of history in their works. The researcher has conducted a close reading of the poems of Michael

Harper, Jay Wright, and Robert Hayden to assess the degree that they rely on historical sources; to gauge how they transform those sources; and to determine the

personal and political ends that poetry is made to serve in their art.

## **Abandoning Answers: George Bernard Shaw's Lack of Misogyny**

Researcher: Associate Professor Anne Marie Drew

Written for the forthcoming volume Staging the Rage: The Web of Misogyny in Modern Drama, this article examines Shaw's lack of misogyny in four of his major

plays. Beginning with an analysis of Arms and the Man and moving to Too True to be Good, the essay explores Shaw's shifting dramatic form and views of women.

## **Reclaiming the Image: Elizabeth Tudor and Princess Diana**

Researcher: Associate Professor Anne Marie Drew

Written for the forthcoming volume Women and the Media, this essay compares Elizabeth and Diana in terms of their ability to control their own press. By focussing on two pivotal incidents in the lives of both

royal women, the author argues that the women reclaim a piece of their identities by controlling the images they want the world to see.

## **Lady of Lyons**

Researcher: Associate Professor Anne Marie Drew

As part of the USNA's 150th anniversary celebration, the Masqueraders will be mounting a production of Bulwer-Lytton's Lady of Lyons, the very first dramatic production presented by the mids in 1846. The

researcher is in the process of generating an acting edition of the play and a theatre history of the piece which will be used as a text in Plebe English classes in the Fall of 1995.

## **The Critical Response to Anais Nin**

Researcher: Professor Philip K. Jason

Although her work has attracted critical attention for over sixty years, there has not yet been a representative gathering of responses to Anais Nin's achievement. The current project will fill this gap by bringing together a selection of reviews, essays, and sections of books that will demonstrate the wide range of opinion as well as its chronological contour. While some critics insist that Nin is a coterie writer, others maintain that she is an

important voice in twentieth-century literature as well as a daring innovator. Divided into general assessments, assessments of Nin's fiction, and assessments of her diaries, the collection will include an introductory overview as well as a bibliography of secondary sources. Planned for completion in 1996, the volume will be published the following year by Greenwood Press.

## **The Biblical Matrix of Mary Gordon's Final Payments**

Researcher: Associate Professor Eileen T. Johnston

This forty-page article demonstrates the ways in which Mary Gordon's Final Payments draws from Biblical sources and Christian tradition in its delineation of characters, themes, and plot construction. It places special focus on the figure of Moses, on the Christian idea of losing one's life to gain it, on the Gospel stories

of Mary and Martha of Bethany and Mary Magdalene, and on the theology and liturgy associated with the Crucifixion of Jesus Christ. This article is being revised at the request of the editor of the journal Christianity and Literature, where it has had favorable reception.



## **The Legacy of Tennyson's In Memoriam A. H. H., 1853-1900**

Researcher: Associate Professor Eileen T. Johnston

This is a long-term project. Its purpose is to determine the nature and extent of In Memoriam's influence upon English poetry between the time of its publication (1850) and the end of the Victorian period. Many of the works under investigation are neglected masterpieces. Others are of interest principally to

literary historians and reception theorists and critics. This investigation involves categorization, contextualization, comparative and critical analysis, and study of the reception of the works of some twenty poets influenced by Tennyson's masterpiece.

## **Discernment in Victorian Literature**

Researcher: Associate Professor Eileen T. Johnston

This study examines the presentation of moral and vocational decisions in Victorian literature, and relates these literary renderings to their roots in the literature of Christian discernment. Tennyson's Idylls of the King and the fiction of Charles Dickens and Charlotte Bronte

are deeply rooted in this tradition. Special attention is being given to the psychological dimensions of discernment--especially in the depiction of desolation and consolation--and to the angelic and demonic iconography associated with discernment.

## **Henry Fielding's Novels and the Classical Tradition**

Researcher: Assistant Professor Nancy A. Mace

Although scholars have noted that Henry Fielding often uses classical allusions and quotations in his novels, they have underestimated the importance of the classics to our understanding of his audience, sources, characterization, and rhetorical techniques. By studying his classical references within the context of

what readers in the eighteenth century knew about ancient literature, we gain new insights into Fielding, his readers, and genealogy of his fiction. The manuscript has been accepted by the University of Delaware Press and will be published in the next 18 months.

## **The British Music Trade in the Late Eighteenth-Century**

Researcher: Assistant Professor Nancy A. Mace

Although music publishing is important in the history of eighteenth-century theatre, music, literature, and the print trade, scholars have virtually ignored this area. Beginning with a collection of thirty lawsuits in the Public Record Office, London, which have been hitherto unknown to scholars, the researcher is studying the music trade in the late eighteenth century--the

relationship between book- and musicsellers, their conflicts over copyright, and their business practices. This project began two summers ago. A database of musicsellers and others named in the suits has been developed, and many materials have been transcribed. It will eventually lead to a book.

## **Homer nods and Fielding Winks: A few narrative problems in Jonathan Wild**

Researcher: Assistant Professor Nancy A. Mace

Many critics have considered Henry Fielding's Jonathan Wild a problematic work because of its supposed heavy-handed irony and the unevenness of the characters and the narrative structure. This project will demonstrate that the "problems" of the narrative are, in

fact, clues that we cannot identify Henry Fielding with the narrator of this novel. In Jonathan Wild Fielding has created a narrative persona through whom he can satirize his own contemporaries who write without sufficient learning or moral judgment. This article has

been written and has been submitted to a journal for

publication.

## **Ethical Impetus in the Founding of USNA**

Researcher: Associate Professor Robert D. Madison

Current research has focused on ethical problems in the navy in 1845, their resolution, and the implications for the initial goals of USNA. In particular, the question of

Bancroft's intentions for an ethical component to education gains weight from his role in the Voorhees courts-martial of 1845.

## **Hemingway's Complex 'Enquiry' in Men without Women**

Researcher: Professor Charles J. Nolan, Jr.

Though Archibald MacLeish recognized at the time that, as he wrote Hemingway, "A Simple Enquiry" is "in your real manner, a fine cool, clean piece of work, sure as leather, & hard and swell," critics have been slow to give it the attention it deserves. MacLeish also made clear the complicated nature of the work when he noted in the margin of his letter: "Ten things 'said' for

every work written. Full of sound like a coiled shell. Overtones like the bells at Chartres. All that stuff you can't describe but only do--& only you can do it" (MacLeish, Letters 199). "A Simply Enquiry" is, in fact, a "complicated" exploration of human relationships.

## **"Ten Indians": Hemingway's Complex Artistry**

Researcher: Charles J. Nolan, Jr.

Another in the saga of Nick Adams' development, "Ten Indians, which first appeared in Men Without Women (1927) along with such now famous short works as "The Killers" and "Hills Like White Elephants," developed slowly. Its compositional history, however, is only one of the interesting aspects of a lyrical tale

about a boy's first heartbreak. In fact, this deceptively simple and wonderfully crafted story contains within it and its manuscript versions a complexity not immediately apparent, telling us quite a bit about its author's artistic choices.

## **Chaucerian Satire**

Researcher: Professor Timothy D. O'Brien

This project is designed to develop a theoretical and historical groundwork for reading Chaucer's Canterbury Tales as a satire. Though much commentary on Chaucer praises the satiric elements in his works, only two books take a rigorous, generic approach to his

satire; and they cover very little of the Canterbury Tales. This project will focus on works describing Chaucer's society, on studies in the genre of satire and in genre theory, and on other satiric works of Chaucer's age.

## **A History of Presidents Hill in Annapolis**

Researcher: Professor Michael P. Parker

The area of Annapolis now known as Presidents Hill lies between West Street, Taylor Avenue, and the old Baltimore, Washington, and Annapolis Railroad right-of-way. It consists of four streets: Monroe Court, Madison Place, Hill Street, and Jefferson Place. The neighborhood was first developed by the Brewer family in the early 1890s as a fashionable suburb of Annapolis;

the crash of 1893, however, sent real estate prices plummeting, and the remainder of the lots were developed on a less pretentious scale. In the early 1900s Presidents Hill was the home of many small businessmen and craftsmen, including some who went on to become significant forces in the Annapolis commercial community. Two mayors of Annapolis

lived in Presidents Hill; another, current mayor of Annapolis Alfred A. Hopkins, has close family links to the community. The neighborhood began to change dramatically in the 1960s as the traditional family and social networks that held it together were eroded; the availability of Title 8 low-income housing moneys led to a marked increase in rental property in the neighborhood. In 1984 Presidents Hill was included in

the Annapolis Federal Register Historic District, and it has increasingly become subject to gentrification over the last decade. This history will trace the chronicle of Presidents Hill from its founding up to the present day, relying on interviews with long-time residents, newspaper accounts, and property records. A building-by-building survey of the community's architectural land historic landmarks will complement the narrative.

## **An Edition of the Poems of Edmund Waller**

Researcher: Professor Michael P. Parker

Although one of the most accomplished and influential poets of the seventeenth-century, Edmund Waller has remained largely neglected by modern critics. This neglect is due primarily to the lack of a reliable standard edition of his works. The most recent edition, that of George Thorne Drury, was published one hundred years ago, in 1892, and it fails to meet the exacting standards of editorial practice established by W. W. Greg, Ferdson Bowers, and Thomas Tanner in the twentieth century. Several scholars have begun new editions of Waller over the past seventy-five years, but none has been brought to completion. Most recently Philip R. Wikelund of Indiana University labored over

an edition from 1954 until his death in 1989. The researcher, in conjunction with Professor Timothy Raylor of Carleton College, has taken over Wikelund's work. The first stage of the project entails producing a census of Waller editions and manuscripts as well as a complete bibliography of secondary works by Waller. The second stage is to reexamine Wikelund's theory of the Waller copy-text: his choice of the 1664 edition may not conform to modern editorial practice. This project is large in scale and will take a number of years to complete, but the result will be a major contribution to modern scholarship.

## **Missing Normal**

Researcher: Professor Molly Tinsley

Novel in progress. This work interweaves the stories of three characters--a woman, her thirteen year old

daughter, and an unemployed poet--during an autumn of abnormally cold weather.

## **Holiday**

Researcher: Professor Molly Tinsley

This story concerns the experience of a middle aged couple on vacation in a tropical, Spanish-speaking

country. This work is completed and in circulation.

## **Log of Stargazer**

Researcher: Professor David Tomlinson

In 1921, the Ben Kings started a cross-country journey which they expected to last almost a year. It did. The trials and tribulations they face in that year--largely because travel by car was so unpredictable--makes interesting reading. Olive King kept a meticulous diary during the year, using her considerable skill with the

language and an intriguing point of view to snare readers. The manuscript diary, kept in the Farmers National Bank vault until after Olive's death in the 1980s has never been published; and the research work done so far reveals that no diary like it has catalogued the life on the road during the 1920s in America.

## **Songs in the Night**

Researcher: Professor John Wooten

Songs in the Night is a first novel under development for two years. Represented by an agent, it is making the

rounds of selected publishers and has received encouraging responses.

## **Ceremonies of the Horsemen**

Researcher: Professor John Wooten

Ceremonies of the Horsemen is the tentative title for the sequel to Songs in the Night. It is half-complete at this

time and work on it will continue throughout the summer.

# **Research Course Projects**

## **The Characterization of African-American Men in Fiction by African-American Women**

Researcher: Midshipman 1/C Caroline E. Magee

Advisor: Professor Fred M. Fetrow

Sponsor: Trident Scholar Program

The researcher set out to examine an extensive, representative sampling of contemporary literature by African-American women writers to analyze critically the methods and results of portraying fictional African-American male characters in such works. The goal was an objective assessment of whether the male image was a manifestation of a political or social agenda, or a more complex phenomenon in a larger literary context. The results of the study indicate that, collectively,

African-American women's writing cannot fairly be classified as anti-male. The genre is too complex and multi-faceted to lend itself to such easy generalizations. A more accurate, but similarly sweeping statement may be that these authors show enormous compassion as they repeatedly express the collective desire for mutual understanding and happiness among both African-American genders.

# **Publications**

ARBUTHNOT, Nancy, Associate Professor, "Mexico Shining: Songs of the Aztecs ". Colorado Springs: Three Continents Press, 1995.

Translations of about 50 lyric chants by the ancient Aztecs of central Mexico--hymns to their gods, ceremonial chants in celebration of marriage, childbirth, victory in war, and so forth--based on 19th- and 20th-century translations into English and Spanish by poets, scholars, and anthropologists. Included also is a general introduction to Aztec history, culture, and their oral literature traditions. These translations are "free" translations in the tradition of Ezra Pound, maintaining the spirit of the original, but not necessarily preserving each word. Much of the

repetition is deleted, but the narrative thread of the chants is kept, something which very few translators have done. These are "versions" more than translations, poems based on Aztec chants, but attending to the rhythms and word play of the originals.

ARBUTHNOT, Nancy P., Associate Professor, "Review of Cathy Song ", School Figures, Poet Lore, 90 (1995), 64-65.

In her third book of poems, Cathy Song probes the complex worlds of family relationships--both those of the second-generation Asian-American family of her childhood, and those of her own children and husband--with polished phrasing, generous spirit, and

accomplished wisdom. Song is a poet to attend to.

BOOTH, Allyson, Assistant Professor, "Battered Dolls." *Images of the Child*. Ed. Harry Eiss. Bowling Green, Ohio: Bowling Green State University Popular Press, 1994. Pp. 143-52.

Premised on the idea that dolls in children's literature are not just objects but characters and problematized by the fact that most doll characters are female, this paper examines some of the implications of how authors handle the issue of damage to a doll's body.

BOOTH, Allyson, Assistant Professor, "The Architecture of Loss: Teaching *Jacob's Room* as a War Novel." *Proceedings of the 1994 Virginia Woolf Conference* published by Pace University Press, 1995.

The paper traces the ways in which World War I--its vocabulary, its perceptual habits, its injured--makes itself felt in Virginia Woolf's *Jacob's Room*. Published in 1922, the novel traces the life of a young man who eventually dies in the war. The researcher argues that the book devotes itself to the preparation for and delineation of that loss and describes one way of unfolding these patterns to students.

DREW, Anne Marie, Associate Professor, "Empty Nest, Full Life," Nashville: Abingdon Press, 1995.

Written from a religious viewpoint, this book weaves the personal experiences of the author with the stories of scores of women. Starting with a discussion of the fear and sadness the empty nest can bring, the book moves into a discussion of the freedoms and opportunities for new growth that the empty nest affords.

DREW, Anne Marie, Associate Professor, "May Meditations," *My Daily Visitor*, May 1995, 3-31.

A series of 31 daily meditations, these reflections are tied to the lectionary readings for the day. Each meditation combines scriptural reference, daily reflection and concluding prayer.

DREW, Anne Marie, Associate Professor, "Eyelashes in the Wilderness," *God's Word Today*, April 1995, 46-50.

This article examines the ordinariness of Christ's life as it is manifested in both the New Testament and the geography of the Holy Land. Accepting Christ's divinity as a given, the article discusses the insights to be gained from close attention to his humanity.

DREW, Anne Marie, Associate Professor, "When Passion and Rage Defeat Restraint," *Delaware State News*, 10 July 1994, 6.

Written shortly after the arrest of O. J. Simpson, this essay sets forth the proposition "Most women and men are capable of anything given the right set of circumstances." The essay discusses the ways in which O.J.'s plight reflects the human condition.

FLEMING, Bruce E., Associate Professor, "Woolf Cubs: Current Fiction," *Antioch Review*, 52.4 (Fall 1994): 549-565.

Taking as its starting point the seminal essay by the English novelist Virginia Woolf that distinguishes between literature prior to the Modernist age and the works of the Modernists, this article considers six novels of the last three years to argue that contemporary fiction in American is in some sense the legitimate inheritor of Woolf's sensibility and that virtually all authors working today are "Woolf Cubs." It considers works by Frederick Rusch, James Dicky, Melanie Rae Thom, and others. Finally it characterizes post-Woolf fiction as giving preference to characterization over plot, and asks why contemporary fiction cannot be structured more rigorously on plot.

FLEMING, Bruce E., Associate Professor, "You Can't Hardly [sic] Get There Without a Program Note," *New Dance Review* 12 (Winter 1995), 12-15.

Taking as its point of departure a performance of a new choreographic work by Graeme Murphy entitled "Beyond Twelve," this essay considers the larger issue of the relevance of explanatory material extrinsic to dance and theater productions, usually included in the printed program handed out to patrons. Conducting the "thought experiment" of perceiving the work in question without prior preparation from the program notes, the critic notes how perceptions of the work alter through outside information. What is the relation of commentary, or scholarly preparation, to the actual artwork? This question is relevant to classroom presentation of written works as well as to the stage presentation of dance and theater. Without reaching firm conclusions, this essay lays out the pros and cons of both positions, that explanatory material is necessary and that the work itself should be self-explanatory.

FLEMING, Bruce E., Associate Professor, "Toward a Theory of Dance History," *Ballet Review*, 22.2 (Summer 1994), 64-72.

Considers the fundamental problem of history in dance research, posed by the fact that until recently there

existed no reliable method of annotating dance works, that was passed down from body to body, dancer to dancer. Even those annotation schemes which have been developed in this century suffer from various defects, which make it impossible to speak, in the context of dance, of correct or incorrect transmission of the work, or finally to speak in terms of a "text" for dance works at all. The contrast is posed between dance on one hand and all the other arts, including other performing arts, on the other. Examples are mined from the parallel between painting and dance, and their contrast, in the form of an exhibition of the works of the Italian Renaissance painter Andrea Mantegna at the Metropolitan Museum of Art.

HILL, John M., Professor, "The Cultural World in *Beowulf*," Toronto and London: University of Toronto Press, 1995.

Taking an anthropological approach, this study opens up the social world dramatized in *Beowulf* by focussing on the systems of exchange and feud in the poem, as well as on the functions of genealogies, and the legalistic roles of kings, hero, warriors, and kinsmen as well as the social functions of queens.

HILL, John M., Professor, "Transcendental Loyalty in *The Battle of Maldon*," *Medievalia*, 21, 1995, 75-95.

Argues that the loyal retainers who die in battle for their dead lord enact a new standard of loyalty for Anglo-Saxon times--one they forge transactionally on the battlefield in imitation of a transcendent standard (one that transcends lived arrangements or agreements).

JASON, Philip K., Professor, "Missing Pieces: Versions and Visions of Vietnam POW/MIA in American Culture," *War, Literature, & the Arts* 6.2 (Fall/Winter 1994), 63-70.

Prisoner-of-war narratives from the Vietnam War reveal a wide range of political and ideological agendas. As literary types, these narratives share elements with other confinement narratives, including particularly crises and affirmations of faith. The story of the captured aviator/officer held at the "Hanoi Hilton" dominates the literature, crowding out narratives of other prisoners and locations. While most of these narratives tend to support and defend U. S. goals, several do not. MIA representations concern the mythological dimensions of disappearance and absence; thus, the MIA is often a symbol for a missing or lost aspect of American character.

MACE, Nancy A., Assistant Professor, "What Was

Johnson Paid for *Rasselas*?" *Modern Philology* 91 1994, 455-458.

In the standard edition of Samuel Johnson's *Rasselas* published in 1990, Gwin Kolb states that common opinion that Johnson was paid 100 pounds for the first edition of this work and 25 pounds for the second edition. A lawsuit discovered in the Public Record Office, London, reveals that this assumption is false. The bill of complaint in this suit records verbatim Johnson's assignment of the copyright to William Strahan, the Dodsleys, and William Johnston. It reveals that Johnson was paid only 75 pounds for the first edition of this work.

MACE, Nancy A., Assistant Professor, "The History of the Grammar Patent, 1547-1620," *Papers of the Bibliographical Society of America* 87, 1993, 419-436.

Because it involved some of the most important members of the Stationers' Company and is one of the few royal patents granted continuously from the sixteenth through the nineteenth centuries, the grammar patent can add substantially to our knowledge of the developments leading up to the first copyright law in 1610 and to our understanding of the dynamics of the seventeenth- and eighteenth-century book trade. This project traces the history of the patent from 1547 to 1620; this period in its history is not clearly understood by scholars. Research thus far has revealed that the patent was considered one of the most valuable granted to printers; it has also uncovered the identities of several individuals who were not known to be involved with the grammar.

MADISON, Robert D., Associate Professor, "Hymns, Chanteys, and Sea Songs," *American and the Sea*, ed. Haskell Springer. Athens, University of Georgia Press, 1995, 99-108.

Not surprisingly, the music of America reflected a cultural bias toward nautical subjects. Within the different genres represented in American music, maritime imagery is pervasive, and maritime subject matter frequent.

MADISON, Robert D., Associate Professor, "Review of *The Red Rover* and *Notions of the Americans*" *Resources for American Literary Study* 20.1, 1994, 122-24.

Contemporary editing theory, as developed in part by the editors of *The Red Rover*, suggests different editorial decisions than those made by present editors, and this presents an inconsistency in the edition. Moreover, there seems to be some hesitancy as to

whether Notions should be edited and annotated as fact or fiction.

NOLAN, Charles J. Jr., Professor, Contributions to the "Annual Bibliography of English Language and Literature for 1991," Volume 67, Eds Gerard Lowe and D. Gene England. Leeds: Modern Humanities Research Association, 1994.

Contributions to the Annual Bibliography come from a careful review of the many issues of selected journals. The contributor examines and notes any article, edition, book, or thesis, published in any language, that has an important link to English and American language or literature and any ancillary work that bears significantly on those fields. The Annual Bibliography is one of the two major bibliographies in English studies.

O'BRIEN, Timothy D., Professor, "The Breton Lays," Dictionary of Literary Biography: Old and Middle English Literature. Vol 146. Eds Jeffery Helterman and Jerome Mitchell. Brucoli Clark Layman: Washington, DC, 1994, 343-349.

This article defines the genre "Breton Lay" as it occurs in Middle English Literature. It details the source(s) of the genre in Celtic tales and, more literarily, in Marie de France's 12th-century collection of lais. Criticism of this genre has been limited primarily to three works: Sir Orfeo, Sir Launfal, and Chaucer's Franklin's Tale. Though some distinguishing features of the genre do exist in Marie's lais, the extant English pieces display very little that distinguishes them from the metrical romance. Apparently, an author's calling a romance a Breton Lai was as much a gesture to enhance the status of the work as a reliable commentary on genre.

PARKER, Michael P., Professor, Review of Michael C. Schoenfeldt, "Prayer and Power: George Herbert and Renaissance Courtship" George Herbert Journal, 17.1 (Fall 1993), 76-79.

Schoenfeldt's study points out the continuities between the poet George Herbert's early career as a courtier and

his later embrace of holy orders as an Anglican priest. In what might be described as "moral archaeology," Schoenfeldt uncovers the basic cultural suppositions that prop the poetic superstructure: he authoritatively traces Herbert's rhetorical strategies back to their roots in Jacobean manners and moral imperatives. The most controversial section of Power and Prayer is Schoenfeldt's examination of the erotic element of Herbert's religious poetry; his treatment is convincing but sketchy, and it will undoubtedly provide ample material for subsequent study.

TOMLINSON, David O., Professor, "Exploring the Information Superhighway," The Computer-Assisted Composition Journal (Summer 1994), 4-17.

What uses might English teachers make of the computer and the Internet services available at many schools? The article organizes the services available and tells how the author has used most of them to enrich his writing and literature classes.

TOMLINSON, David O., Professor, "Review of Tom Quirk's Coming to Grips with Huckleberry Finn: Essays on a Book, a Boy and a Man," Mark Twain Forum, Internet Discussion List, June 5, 1994

Tom Quirk writes essays which convey more than information. They reach out and ensnare a reader. These essays are both informative and enjoyable. They are worth using not only by professors but by their students who are investigating Huckleberry Finn.

TOMLINSON, David O., Professor, "Review of Anthony K. Berret's Mark Twain and Shakespeare: A Cultural Legacy," Mark Twain Forum Internet Discussion List, February 15, 1995.

Twain continually used ideas from Shakespeare's plays in his writing. This book, however, does not examine those uses in a way which will either inform the Twain scholar or entertain him. Berret gets caught up in his own effort to systematize Twain and forgets about the spirit which motivates both Twain and Shakespeare as writers.

## Presentations

BOOTH, Allyson, Assistant Professor, "South Pole/Western Front: Waste Lands of Eliot, Shackleton and the Great War," Carolinas Symposium on British Studies, Norfolk, Virginia, 15 October 1994.

BROWNE, Marlene, Associate Professor, "You Can Be Whatever You Want to Be," Zion Baptist Church, Baltimore, Maryland, June 1994.

CLARIDGE, Laura, Associate Professor, "The Object of Romanticism," Duke University Conference on Romanticism, Durham, North Carolina, 12 November 1995.

FETROW, Fred M., Professor, Chair, African-American Women Writers Section, Northeast Modern Language Association; 1995 Convention Panel: "African American Women Playwrights: The Current Scene," Boston, Massachusetts, 31 March 1995.

FETROW, Fred M., Professor, "African-American Heroes in the Poetry of Robert Hayden," Black History Month at Central Middle School, Edgewater, Maryland, 9 February 1995.

FETROW, Fred M., Professor, Participated in Middle States Association Self-Study Workshop(s), Philadelphia, Pennsylvania, 29-30 November 1994.

HILL, John M., Professor, "Warfare and the Construction of Kinship in Anglo-Saxon Heroic Poetry," International Medieval Association, Kalamazoo, Michigan, 7 May 1995.

JASON, Philip K., Professor, "Vietnamese in America: Literary Representations," Popular Culture Association, Philadelphia, Pennsylvania, 13 April 1995.

MACE, Nancy A., Assistant Professor, "Henry Fielding and the Influence of Lucian Reconsidered," International Society for the Classical Tradition, Boston, Massachusetts, 11 March 1995.

MADISON, Robert D., Associate Professor, "James Fenimore Cooper and the Founding of the Naval Academy," American Literature Association, Baltimore, Maryland, 20 May 1995.

NAVRATIL, Joseph S., Lieutenant, USN, "A Soldier's Protest: The Dilemma of Siegfried Sasson," Popular Culture Association Meeting, Philadelphia, Pennsylvania, 14 April 1995.

NOLAN, Charles J. Jr., Professor, "Hemingway's Complex 'Enquiry' in Men Without Women," Northeast Modern Language Association, Boston, Massachusetts, 31 March 1995.

NOLAN, Charles J. Jr., Professor, Chair of a Panel, Conference on College Composition and Communication, Washington, DC, 23 March 1995.

RUENZEL, Stephanie, Lieutenant, USN, "Focusing on Autobiographical Self-Construction in Freshman Composition," Conference on College Composition and Communication, Washington, DC, March 1995.

THOMSON, John M., Lieutenant Colonel, USAF, "The Electronic Administration of the English Department," Conference of the College English Association--Middle Atlantic Group, Emmitsburg, Maryland, 8 April 1995.

TOMLINSON, David O., Professor, "Pudd'nhead Wilson: Mark Twain's Magnificent Failure," SAMLA, Baltimore, Maryland, 14 October 1994.

TOMLINSON, David O., Professor, "Eddie Didn't Do Standup: Some Keys to Poe's Humor," American Humor Studies Association, Cancun, Mexico, 8 December 1994.

TOMLINSON, David O., Professor, "Touring America in a Model T," Popular Culture Association Convention, Philadelphia, 13 April 1995.



## History

Associate Professor Nancy W. Ellenberger  
Chair

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The research carried out by midshipmen and faculty in the History Department during AY94/95 reflects the increasing diversity of interests and approaches as the department broadens its expertise beyond naval, American and European studies. This year saw substantial publications on labor in the Belgian Congo (Associate Professor Samuel Nelson), 18th century Iranian politics (Assistant Professor Ernest Tucker), the OSS in china (Assistant Professor Maochun Yu), and modern Peruvian politics (Professor Daniel Masterson), Anne Quatararo's work on the deaf community in 19th century France and Professor Robert Love's edition of Admiral Sir Bertram Ramsey's 1944 diary. Nine faculty members gave conference papers on topics ranging from AIDS in Africa to Eric Voegelin's conception of Gnosticism.

Two members of the department were awarded substantial research grants. Associate Professor David Peeler won a prestigious National Endowment for the Humanities fellowship to pursue his work on twentieth century American photography. Professor Robert Love's Department of Defense legacy grant continued to support a project to bring Soviet Navy Archives to a repository at the Naval Academy.

A number of midshipmen carried out independent research projects, including five students in the History Honors Program. These history majors investigated topics ranging from the Zulu War of 1879, to the Falklands War, and the U.S. Asiatic Fleet in 1941.

## Sponsored Research

### The Sense of History at 8th- and 9th-Century Fulda

Researcher: Asst Professor David F. Appleby  
Sponsor: Naval Academy Research Council (OMN)

Now entitled "Rudolf, Abbot Hrabanus and the Ark of the Covenant Reliquary," this project addresses the view of history of Hrabanus Maurus, a ninth-century abbot of the important German Benedictine monastery at Fulda. It employs the philological and history-of-ideas methods commonly used in the study of medieval religious culture. The discussion focuses on the transferal of holy relics (the remains of dead saints) from Rome to Fulda and the special reliquary that Hrabanus built to house the relics. The significance for Hrabanus of this "Ark of the Covenant" reliquary may be understood by reference to the abbot's numerous references to the original Ark of the Covenant scattered

throughout his commentaries on the historical books of the Old Testament. In ninth-century Germany, the acquisition of these relics signalled the abbot's Roman and orthodox orientation. The placement of relics in a container modelled on the Ark of the Covenant suggests a wider panorama of salvation history, in which the monastic foundation at Fulda marks a stage in the expansion of the church in time, but in which the monks of Fulda direct their attention beyond historical time to eternity. This article has been accepted for publication in the American Benedictine Review, a scholarly journal devoted to issues concerning monastic history and spirituality.

### **Elections and the Political Communities of Colonial Virginia, 1728-1775**

Researcher: Assistant Professor John G. Kolp  
Sponsors: Naval Academy Research Council

Elections to the eighteenth-century Virginia House of Burgesses have been of long-standing interest to historians because of the role they played in the early political careers of a number of America's Founding Fathers. Although these men were selected for office within their local county constituencies by a substantial proportion of the adult male population, it has never been completely clear what meaning should be attached to these political events. What did this selection process prove? Was there any real difference between candidates? Did it really matter who won? Were these events merely social gatherings or was something important being decided at these elections? Despite considerable attention by scholars in several books and numerous articles, the precise way these elections fit into the social and political structure of colonial communities has remained obscure.

Examination of surviving data on all elections for this period reveals a pattern of gradual decrease in

electoral competitiveness over the 50-year period, but also demonstrates substantial regional variation which does not fit traditional interpretations. Further, a number of themes emerge from detailed case studies of three counties, including the importance of tenants in the election process, the broad spectrum of issues colonial voters thought germane, the remarkable stability of voting behavior, the importance of previous officeholding to candidate success, and the role of local neighborhoods in defining electoral choice. General revisions to entire manuscript and research and partial writing of new chapter undertaken in 1994-1995.

Publication contract with Johns Hopkins University Press to include book in new series on "The History, Context, and Culture of Early America" under general editorship of Jack P. Greene and J.R. Pole. Manuscript completion expected August 1995; publication expected in 1996.

### **Soviet Navy Archives Project**

Researcher: Professor Robert W. Love, Jr.  
Major Sponsor: Department of Defense Legacy Program

The Soviet Navy Archives Project aims to assemble at the Naval Academy newly available documents on the Soviet Navy and other aspects of Soviet policy during the Cold War. In association with Roskomarchiv and the Russian Ministry of Defense, the Project brought to Moscow in September an American delegation of fifteen scholars for a conference on "The Navies, Nuclear Weapons, and the Caribbean Crisis, 1962," which was co-sponsored by the Naval Academy and various Russian Federation establishments. The Project

also represented the U. S. Navy at an international historical conference held in April 1995 by the Russian Navy to commemorate VE Day. Lastly, SNAP is sponsoring the participation of three Russian historians at the 21-24 June 1995 Annual Meeting of the Society for Historians of American Foreign Relations at the Naval Academy. SNAP's main work is to exchange documents on specific aspects of the Cold War naval struggle with various Russian Navy repositories and naval historians and other Russian Federation archives.

### **Hegel's Map of the Imagination**

Researcher: Asst Professor Clarence F. Sills, Jr  
Sponsor: Naval Academy Research Council (OMN)

Now entitled "Hegel's Tropological Gnosticism", this project is a major re-thinking of the procedures of inquiry and the claims for completeness embodied in G. W. F. Hegel's influential but difficult project of "speculative logic." Now nearing completion, the project has made a sustained inquiry into the value which the notion of "trope" can have in comprehending

and assessing the Hegelian corpus. The correlation of skeptical and poetic tropes has been demonstrated (a paper summarizing this aspect of my research, "Hegel's Pyrrhonian Poetics: Tropology and Systematic Inquiry" has been accepted for publication by Philosophy Today), and the utility of the tropological approach is being tested by using it as a basis for answering the

influential critique of Hegel mounted by Eric Voegelin. This aspect of the project was explored in a presentation to the Panel "Hegel and Voegelin in Dialogue" organized and chaired by this researcher, which occurred under the auspices of the Eric Voegelin Society at the 1994 American Political Science

Association Annual Conference in New York, September, 1994. A version of this presentation will be submitted for publication this fall.

A completed draft of the book will be submitted for publication this summer.

### **The Ottomans in the Caucasus, 1720-1750: The Case of Daghistan.**

Researcher: Assistant Professor Ernest Tucker  
Sponsor: Naval Academy Research Council (OMN)

In the 1720s, neither Iran, nor Russia, nor the Ottoman Empire, became involved in the Caucasus for the sake of mere territorial expansion. By this time, the region served as a buffer to prevent the other two powers from threatening Anatolia and the central Ottoman lands.

This project examined the Ottomans' cultivation of patron/client relationships with the khans of Daghistan. The Ottomans placed less emphasis on establishing direct rule over the region than on cultivating the friendship and loyalty of existing local leaders. Although the Ottomans officially possessed Daghistan between 1724 and 1736, they did not really try to incorporate it as an integral part of their empire. Instead, they forged flexible relationships with the local khans which could continue whether or not they actually governed the territory.

The project consisted of an analysis of Ottoman documents, letters and records from the period, combined with a study of the relevant chronicles and secondary materials. It essentially confirmed a working hypothesis that even when forced into a defensive situation, the Ottomans did not simply abandon this region, but effectively exploited its characteristics to thwart the designs of Iran and Russia. While the Ottomans may not have gained any territory by espousing such a strategy, they did use it to counter the plans and projects of their enemies with remarkable success and relatively little cost over a long period of time. Research was concluded in December, 1994, and an article detailing findings will soon be submitted to the *Turkish Studies Association Bulletin* for publication.

### **The Robe Brothers in Eastern Sichuan During Republican China, 1911-1949**

Researcher: Assistant Professor Maochun Yu  
Sponsor: Naval Academy Research Council (OMN)

During the Republican period, the Robe Brothers was the largest secret society in Southwest China; its members permeated every major aspect of society and played a major role in the development of Sichuan power relations during these years. One fifth of Sichuan's warlord armies were secret Robe Brothers in the 1920s. It dominated the smuggling of opium, morphine and arms in Sichuan. When Chiang Kai-shek and the Nationalist government moved to Eastern Sichuan and chose Chungking (Chongqing) as China's Capital during the War Against Japan (1937-1945), the Robe Brothers became one of the most powerful forces to be dealt with. In the end, this secret society was transformed into a quasi-intelligence and terrorist organization that would both benefit China's war efforts and antagonize domestic factions.

This research addresses the key issue of whether China historically had amicable, therefore workable, state-society relations. The case study of the Robe Brothers will add to the current historical debate among Chinese historians a new perspective. Robe Brothers in Sichuan was often a paradox of good and evil combined, duty and right blurred. A Robe Brother might save a drowning woman's life just easily as he might rape her daughter. Its historical roots of anti-Manchu ideals prompted it to support the Republican (Nationalist) government yet it vigorously carried on its own illicit activities regardless of government intervention. It was thus not unusual when the Robe Brothers became both the target of the government as well as the helper of the government. In this sense, civil power and state power intertwined.

## Independent Research

### Spiritual Progress in Carolingian Saxony: A Case From Ninth-Century Corvey.

Researcher: Assistant Professor David F. Appleby

This study uses documents pertaining to the collection and veneration of holy relics (remains of dead saints) in an attempt to reconstruct the historical outlook and spirituality of the Benedictine monastery of Corvey in Saxony during the second half of the ninth century. The project employs the philological and history-of-ideas techniques commonly used in studies of medieval religious culture. The central conclusion is that despite the violence and coercion of the initial conversion of

the Saxons to Christianity by the Franks under Charlemagne, Saxon authors rapidly developed a positive view of their people's recent history. Within two generations of the conversion, Saxon authors at Corvey were prepared to view the conversion as a manifestation of divine benevolence and were willing to assert the Christian spiritual progress of their own people. This article has been accepted for publication in The Catholic Historical Review.

### Dictionary of Admirals of the U.S. Navy, Vol. III 1919-1941

Researcher: Associate Professor William B. Cogar

The third in the projected series of five volumes, this continues the publication format of the first two volumes. Some 280 men achieved the rank of rear admiral between 1 January 1919 and 31 December 1941. Each of these men are included. For each entry, personal information on them is followed by a detailed chronology of their careers, followed by a paragraph on

"Career Highlights." Finally, there is bibliographical information and a photograph. The series is to provide the most comprehensive resource for biographical information on U.S. Navy admirals. The series is published by the Naval Institute Press. This volume will appear in early 1996.

### Roman Records

Researcher: Professor Phyllis Culham

Roman history to date has over-systematized the fragmentary evidence for Roman law and administration. New anthropological work on premodern societies' use of writing allows us to re-

envision the Roman past. The project has already resulted in a number of published articles and will become a book manuscript. One article which has been completed, and another is forthcoming.

### Domitius Corbulo

Researcher: Professor Phyllis Culham

Domitius Corbulo was most likely the greatest general of the Roman Empire, yet he has never been the subject of a biography. Corbulo has been neglected because he achieved much of what he did through deterrence and a combination of force and diplomacy. His military career is less dramatically appealing than those of

"fighting" generals. In fact, he is the perfect example through which we can explore evolution of strategic thinking in the Roman Empire. The outcome of this research will be a biography putting Domitius Corbulo in his intellectual and strategic context.

## **Latin American Nikkei: The Japanese Experience in Mexico and South America, 1880-to the Present**

Researcher: Daniel Masterson (Co-authored with Sayaka Funada and John F. Bratzel)

This study examines the process of emmigration, settlement and cultural adaption of the Latin American Japanese through three generations. It is based upon extensive research in Japan, the United States, and the

Latin American nations of Argentine, Brazil, Chile, Mexico, Pargaguay and Peru. It is now under contract with Westview Press with a scheduled publication date of late 1996.

## **The Illuminating Mind in Twentieth Century American Photograph**

Researcher: Associate Professor David P. Peeler

The project is an examination of the growth of American photography in the twentieth century. It explores the ideas and values of leading American photographers -- Alfred Stieglitz, Paul Strand, Edward Weston, Ansel Adams and Minor White -- and the ways in which they brought those beliefs to fruition in their work. The principal question is this: In what way did

these creative individuals seek to resolve the tension that arose from working in a medium with an almost worshipful attitude toward objectivity, while daily seeing the evidence in their work that even the simplest fact cannot be presented without altering its "pure" objectivity in some fashion?

## **The Social Impact of AIDS in Africa**

Researcher: Samuel Nelson

AIDS represents an unparalleled threat to world health, particularly in Africa which has the highest rates of HIV infection. This study seeks to explore the social impact of AIDS through a detailed analysis of how victims and their families have conceptualized the illness and sought therapies for their maladies. By collecting numerous case histories from Zimbabwe, this work will examine social and cultural responses made by

individuals, their families, and their health-care providers to the numerous medical, social, and cultural challenges posed by the AIDS epidemic. Specific themes will include the African definition of AIDS and its origins, the structure and operation of lay therapy managing groups, the search for remedies (both indigenous and western), and adaptations in the traditional values of family and community support.

## **Discovering the Signs: Social Images of the Deaf Community in Nineteenth Century France**

Researcher: Associate Professor Anne T. Quartararo

This research project is a synthetic study of the social and cultural forces that created the Deaf community in nineteenth century France. The researcher is focusing on the emergence of a Deaf identity during a period of intense social change in western society. In the first part of the study the revolutionary period is placed in perspective. The researcher is studying the concept of social deviance in terms of charity and public assistance. In the second part of the project, the researcher is studying the emergence of Deaf community associations, initiatives for Deaf education and the role of leading activists to improve the

condition of Deaf people. In the third part of the study, the researcher is looking at the uses of language and the exclusion of sign language from schools that educated the Deaf in the late nineteenth century. The emergence of Deaf culture, through different social associations, is also an important part of the study. Two articles have been accepted for publication during the current academic year, one in Journal of Social History and another in a reader for Deaf history. Another article on the Deaf community in the revolutionary period was published in 1994 in The Deaf Way, edited by Carol Erting.

## **The Origins of the Elihu Root Staff Reforms**

Researcher: Associate Professor William R. Roberts

The purpose of this study is to examine the origins of the staff reforms introduced by Secretary of War Elihu Root. Previous historians have argued that the American General Staff that was created in 1903 was patterned after the Prussian General Staff in order to make the United States Army a more effective fighting force. This study, however, posits that the General Staff and other staff reforms undertaken by the army under Secretary Root represented the culmination of two long-standing struggles for power. The first took

place between line and staff officers, while the second involved the secretary of war and the nineteenth-century commanding general. Supporters of the General Staff that was created in 1903 sought to strengthen the secretary and the line by replacing the commanding general with a chief of staff and by making the existing staff bureaus subordinate to the General Staff. These reforms provided a foundation for the centralized, bureaucratic military establishment of today.

## **Research Course Projects**

### **From Undeclared War to Total War: Adolf Hitler Declares War on the United States**

Researcher: Midshipman 1/C Michael L. Baker

Adviser: Professor Larry V. Thompson

This thesis examines why Hitler declared war on the United States, an act subsequently much criticized by historians and military professionals as gratuitous at best and one which helped guarantee that Germany could not win the war. The author argues that German frustrations associated with the undeclared naval war in the Atlantic prior to December 1941, the opportunities

present then, such as the apparent military defeat of the Soviet Union and the immediate superiority which the Germans assumed the Japanese enjoyed in the Pacific, and the German assessment of American military readiness all combined to create a "now or never" atmosphere in Berlin which reinforced Hitler's predisposition to gamble on strategic matters.

### **"Admiral Thomas Hart and the U. S. Navy's Asiatic Fleet, 1941"**

Researcher: Midshipman 1/C James Butler

Adviser: Professor Robert W. Love, Jr.

Based on research here and in Britain, this Honor's Thesis explains how Admiral Hart, the CinC Asiatic Fleet at the outbreak of World War II, planned with the British to conduct a fighting withdrawal from the Philippines during the early stage of the approaching conflict. The paper revises considerably our understanding of naval policy in the Far East on the eve

of the Japanese attack on Pearl Harbor; contrary to previous scholarship, Midshipman Butler concludes that Hart was indecisive and that his failure to adopt and implement a realistic, coherent strategy contributed to the swift collapse of the Allied naval position in the Southwest Pacific in December 1941 and January 1942.

### **Religion and Philosophy in Contemporary Culture**

Researcher: Midshipman 1/C Dennis Klein

Adviser: Assistant Professor Chip Sills

For this directed reading course Midshipmen Klein read, summarized and discussed with adviser works by C. S. Lewis, Leszek Kolakowski, Philip Rieff, E. F.

Schumacher and Dostoevski. He also produced a term paper synthesizing the perspectives of these authors.

### **German Jews and the *Ostjuden*, 1880-1916**

Researcher: Midshipman 1/C Raphael P. Kuyler  
Adviser: Professor Larry V. Thompson

This thesis investigates the reaction of German Jews to the influx of their co-religionists from eastern Europe in the last third of the nineteenth century. The "easterners" were generally backward, ignorant, and orthodox - visible characteristics which alarmed emancipated and assimilated German Jews, if for no other reason than they feared a renewal of anti-Semitism among Germans that might threaten to

undermine all the progress German Jews had realized since the Enlightenment. In assessing their reaction, the investigator probes the difficulty problem of defining national and cultural identity. Utilizing the German-Jewish press of the time, German-Jewish attitudes toward the newcomers are revealed and the strategies created to assimilate them quickly and/or defend them from German prejudice are examined.

### **Argentine Motivations for the Invasion of the Falklands (Malvinas) Islands**

Researcher: Midshipman 1/C Ramon Lamas  
Adviser: Professor Daniel Masterson

This History Department Honors project examined the institutional military background for the Argentine armed forces decision to invade the Falkland

(Malvinas) Islands in 1982. It was based upon research in Argentine military literature and documents, as well as materials in the United States National Archives.

### **Postwar Conservative Thought**

Researcher: Midshipman 1/C David Maruna  
Adviser: Assistant Professor Chip Sills

This Independent Study focussed on works by Richard Weaver, Eric Voegelin, Philip Rieff, and Friedrich Hayek. Mr. Maruna, in addition to summarizing and discussing a number of challenging works, produced a

research essay on the honor system at the U.S. Naval Academy and submitted the essay for prize consideration.

### **A Lion Disheveled: The Response of the English Press to the Battle of Isandhlwana, 1879**

Researcher: Midshipman 1/C Erich Wagner  
Adviser: Associate Professor Nancy Ellenberger

This paper uses the disastrous defeat suffered by the British army at the beginning of the Zulu War as a vehicle to explore the workings of the British press with regard to colonial war and public sentiments about empire. It examines how the press reacted to the disaster through the use of major newspapers and publications of the period. The Zulu War was not met with uniform condemnation or support by the press,

rather, there were a variety of concerns and opinions expressed by the educated public. Advertisers used the war to sell products, cartoonists lampooned British as well as Zulu warriors, and party lines were not clearly demarcated. In its confusion of responses, the British press reflected the ambivalence of the British public to an empire that required violence and death to sustain itself.

## Publications

LOVE, JR, Robert W., Professor, co-editor, *The Year of D-Day: The 1944 Diary of Admiral Sir Bertram Ramsay* (Hull, England: University of Hull Press, 1994).

Admiral Sir Bertram Ramsay, RN, holds a unique distinction, being the only man in recorded history to move an army in combat across the English Channel both ways. Scion of a 300-year line of Scottish generals, Ramsay entered HMS *Britannia* in 1898, distinguished himself in combat during the 1903 Somaliland War, served as a turret officer in the newly commissioned HMS *Dreadnought*, and fought in the Channel throughout the 1914-1918 conflict. He was in command at Dover when World War II erupted, and planned and commanded the unexpectedly successful evacuation of the British Expeditionary Force from Dunkirk in late May-early June 1940. Exactly four years later, he commanded the Anglo-American naval forces which landed the Allies in Normandy in Operation Overlord and supported their inland movement from France into Belgium, Holland, and Nazi Germany. His tragic death in a plane crash in January 1945 deprived the wartime Allies of the premier amphibious admiral of the Second World War. This thoroughly annotated edition of his 1944 diary, which I located at Cambridge University some years ago, provides an unparalleled view into the workings of Allied higher command during the fateful year of D-Day.

LOVE, JR., Robert W., Professor, "The U. S. Navy and 'Operation Roll of Drums,' 1942," in Timothy J. Runyan and Jan Copes, eds., *The Battle of the Atlantic* (New York: Westview Press, 1994), pp. 95-120.

In an early 1942 campaign codenamed 'Roll of Drums,' German Admiral Karl Donitz deployed a handful of U-boats to the East Coast where they sank over 300 merchantmen during the six months following American entry into the Second World War. Based on extensive multiarchival research here and in Britain, this article explains for the first time the many complex reasons why Admiral Ernest J. King, the new Chief of Naval Operations, was unable to assemble the forces to counter this German submarine offensive for several months.

MASTERSON, Daniel, M., Professor, "In the Shining Path of Mariategui, Mao Zedong, or Presidente Gonzalo? Peru's *Sendero Luminoso* in Historical Perspective," *Journal of Third World Studies*, Vol., XI, No. 1 (Spring 1994), 154-180.

This article examines the ideological orientation of Peru's Maoist guerrilla front, Sendero Luminoso, in the historical context of the evolution of the Peruvian Left. It is based upon interviews with Peruvian civilian and military political leaders, a review of *Sendero Luminoso's* published literature, and archival sources in Peruvian and United States archives.

MASTERSON, Daniel M., Professor, "Peruvian Armed Forces and the Contemporary Crisis in Peru," in *Threats to Democracy in the Andean Region*, Cornell University Latin American Studies Center, 1994, 111-121

This article is published in the proceedings of a conference held at Cornell University in 1992 on contemporary political and international issues in the Andean nations. It offers a contemporary assessment of civil-military relations with the government of Peruvian President Alberto Fujimori.

NELSON, Samuel H., Associate Professor, *Colonialism in the Congo Basin 1880-1940*, Athens: Ohio University Press, 1994, 279 pp.

This monograph of colonialism in central Africa emphasizes African experiences and social change in Zaire, the former Belgian Congo. The author combines archival and neglected oral sources with anthropological research to explore the changing patterns of work among the Mongo, a people who live in the forest regions of the Congo basin. Although colonial rule clearly undermined traditional lifestyles by imposing new labor demands, this study demonstrates that it did not destroy African initiative or creativity. Rather, the Mongo actively shaped their own destiny, transforming their activities, institutions, and values in order to adapt to a changing world. The author also sheds new light on the character of the Belgian colonial state. Its coercive mobilization of Mongo labor ultimately created the profound rural impoverishment that still characterizes and explains underdevelopment in Zaire today.

QUARTARARO, Anne T., Associate Professor, "The Revolutionary Ideal and the Deaf Community in France, 1792-1795," *The Deaf Way: Perspectives from the International Conference on Deaf Culture*, Carol Erting et al., eds. Washington, D.C.: Gallaudet University Press, 1994, 167-171.

The purpose of this article was to analyze the Deaf community in the context of the popular phase of the



French Revolution. The author used selected archival documents in order to measure how revolutionary rhetoric and ideology affected the socio-economic status of the Deaf community. During this period, the national government developed the policy that it should intervene in the lives of Deaf people in order to improve their lot in life. The promises made by these revolutionaries, however, could only be measured in some very small changes in the lives of Deaf people in France. Schools for the Deaf in Paris and Bordeaux could not adequately address the economic and social misery facing most Deaf Frenchmen during this period of upheaval.

TUCKER, Ernest S., Assistant Professor, "Explaining Nadir Shah: The *Tarikh-i Alam'ara-yi Nadiri* of Muhammad Kazim Marvi," *Iranian Studies* XXVI: 1-2 (1993), 95-117.

The article presented the unique legitimizing paradigm of the *Tarikh-i Alam'ara-yi Nadiri* of Muhammad Kazim Marvi, an 18th-century chronicler of Nadir Shah, who was the last Iranian ruler to attempt to build an empire on the scale of Tamerlane. The article argues that the *Tarikh*, written during the time of Nadir's successor, Shahrukh, reveals Marvi's attempt to blend Nadir's Turco-Mongol steppe legitimating devices with the Shi'i religio-political system of legitimation already in place at the end of the Safavid dynasty. Although this novel synthesis did not survive beyond Shahrukh, its articulation by Marvi shows how such concepts

evolved during the interregnum between the Safavid and Qajar dynasties, and suggests ways of thinking about how "modern" Iranian paradigms of political legitimation began to develop in the late 18th century.

YU, Maochun, Assistant Professor, "OSS in China--New Information About An Old Role," in *International Journal of Intelligence and Counterintelligence*, Volume 7, #1, 1994, New York, pp.75-96.

The WWII story of allied intelligence in China in general, and OSS/China in particular, contains elements of immensity and complexity that were unprecedented in the history of foreign espionage. This article attempts to illustrate how an intelligence agency without a solid central command affected America's overall China policy; how the complicated espionage warfare among the Americans, the British, the Chinese Nationalists, and the Chinese and Soviet Communists played out in an environment that was both intense and confusing; how various allied intelligence agencies in wartime China competed with extraordinary zeal for command control and operational turf; and finally, how OSS struggle with tenacity to establish its own independence and command integrity in China.

Two recent factors stimulated the writing of this article: the unprecedented opening of the complete OSS archives by the U.S. government at the National Archives, 6,000 cubic feet in total, and the sudden boom of publications in mainland China on matters related to Communist intelligence during World War II.

## Presentations

LOVE, Jr., Robert W., Professor, "The Impact of World War II on the U. S. Navy," at a conference on "World War II in the Pacific, sponsored by the Naval Historical Foundation, American Society of Naval Engineers, etc., at Crystal City, Virginia, 12 August 1994.

MASTERSON, Daniel M., Professor, "Unwanted Immigrants: The Fate of Peru Japanese, 1939-1950," American Historical Association Convention, Chicago, Illinois, January 6-8, 1995.

MASTERSON, Daniel M., Professor, "Teaching Andean Cultures as a Component of World Cultures Course," Third World Studies Association Conference, Williamsburg, Virginia, October 5-7, 1994.

MASTERSON, Daniel M., Professor, "Unequal Neighbors: The Peru-Ecuador Border Dispute, Invited Lecture, Latin American Studies Center, Michigan State University, East Lansing, Michigan, April 12, 1995.

NELSON, Samuel H., Associate Professor, "A Thematic Approach to Teaching World Cultures," Third World Studies Association Conference, Williamsburg, Virginia, 7 October 1994.

NELSON, Samuel H., Associate Professor, "AIDS in Africa: The Challenges and Strategies of Disease Prevention," Invited Lecture, African Studies, University of Maryland, College Park, Maryland, 2 May 1995.

PEELER, David P., Associate Professor, "America Through Red-Tinted Lenses: A Case for Cold War Imagery," Delaware American Art Symposium, University of Delaware, Newark, Delaware, 31 March 1995.

QUARTARARO, Anne T., Associate Professor, "Celebrating Abbé de l'Épée's Birthday: Investigating Cultural Ritual in the French Deaf Community in the Early Twentieth Century," Second International

## HISTORY

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Conference on Deaf History, Hamburg, Germany, 1 October 1994.

SILLS, Jr, Clarence F., Assistant Professor, "Is Hegel a 'Gnostic' in Voegelin's Sense?", at Eric Voegelin Society, sponsored by and copyright American Political Science Association Annual Conference, New York, New York, September 1-2, 1994.

TUCKER, Ernest S., Assistant Professor, "A Thematic

Approach to Teaching World Cultures," Third World Studies Association Conference, Williamsburg, Virginia, 7 October 1994.

YU, Maochun, Assistant Professor, "Finale of World War II in East Asia," World War Two Studies Association's 50th Anniversary of the end of WWII Conference, the United States National Archives, Washington, D.C., 26 May, 1995.

# Language Studies

Professor Sharon Dahlgren Voros  
Chair

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The Language Studies Department enjoyed a very strong year, with outstanding classroom and scholarly performance by faculty. Faculty members produced 12 articles on French, Spanish, Russian, and German philosophical, cultural, and literary topics, 5 scholarly book reviews, and gave more than 19 presentations at national and international conferences.

In the field of language acquisition, the Annapolis Interactive Video Project continued to create interactive video lessons for French and Spanish, and established plans to develop lessons for Japanese and German, including the development of the next generation of authoring system, Interactive Language Instruction and

Authoring System (ILIAS) with Windows Visual Basic interactive video templates.

The department has enjoyed strong enrollments in all languages and successfully continued the Cox Fund overseas program and internship opportunities at U.S. embassies in France and Spain. We are proud of the large number of minors in all languages (101) among 1995 graduates who have elected to pursue language, literature, and area studies at advanced levels. These graduates will bring to the Navy and Marine Corps not only valuable linguistic skills but also in-depth knowledge of the regions where a specific language is spoken.

## Sponsored Research

### Chinese Interactive Video Listening and Reading Comprehension Lessons

Researchers: Associate Professor William H. Fletcher,  
Research Instructor Yumei Sun, and  
Professor John Hutchins  
Sponsor: National Security Agency

The purpose of the project was to select video clips and print materials on related topics from the People's Republic of China (PRC) and to develop computer-based multimedia lessons based on them to help maintain and enhance listening and reading comprehension skills for government linguists at Federal Interagency Language Roundtable (FILR) levels 1+-2+ as well as for advanced undergraduate learners. The lessons were conceived to be used either as an adjunct to other course work or on a self-study basis. In selecting the clips, factual content in domains of special interest to government linguists was emphasized, but some clips with primarily cultural or human interest focus were included both for variety and to familiarize learners with the cultural context, an essential prerequisite to understanding Chinese. Sources for the video materials were: satellite broadcasts from the PRC provided by Chicago Chinese Communications-TV, primarily recorded from 1994; ten hours of interviews with a variety of citizens from the PRC videotaped by Ms. Sun in Beijing in September 1993; SCOLA news broadcasts from Taiwan and PRC, which were used for a prototype videodisc.

About sixty segments from these materials were selected and compiled into two 60-minute premaster tapes for videodiscs.

Thirteen reading lessons and five interactive video lessons were completed. Additional readings were selected and vocabulary lists were compiled for various clips on the videodiscs. Several factors beyond the control of the U.S. Naval Academy team forced changes to their original project design. Insufficient funds at the sponsoring agency meant that the premaster tapes could not be mastered and pressed onto laser videodiscs. Now that Language Studies has the capability in house, these tapes will be digitized and committed to CD-ROM for distribution. Furthermore, the contract stipulated using the WinCalis authoring system, which had been developed for Chinese under contract to the funding agency. WinCalis was found to be quite unstable and bug-ridden. During the course of the project, WinCalis underwent several revisions, resulting in loss of some lessons which had already been entered. The final delivery of the lesson materials was made on paper rather than computer-based.

## **Chantal Chawaf: Evolution of a Literary Ethic**

Researcher: Assistant Professor Marianne Bosshard

Sponsor: Naval Academy Research Council (OMN)

The goal of this project is to complete a book-length critical analysis of the oeuvre of Chantal Chawaf, one of the better known contemporary French women novelists whose work is an artistic embodiment of contemporary French thought and culture. Upon completion, this book will be published by the Editions Rodopi, Amsterdam, Holland, in their monograph series on contemporary French writers, the "Collection monographique Rodopi en littérature française contemporaine." It will contain six chapters as follows: one on the literary ethics of the author; one on her poetics; one on the theme of the maternal; one on the

topic of the "Other" and the quest for identity; one on the reformulation of ancient myths as they appear, in a new form, in Chawaf's novels, and one on the sociological aspects of her oeuvre.

To date, no comprehensive, up-to-date critical analysis is available on this author, either in English or in French. Once completed, this book will serve as a useful tool in the framework of courses in French literature and culture that include the discussion of ethics, contemporary thought and issues on the bases of which Chawaf's ethical and linguistic endeavors are built.

## **Perceptions of Death and Crime in Modern Russia**

Researcher: Assistant Professor Clementine Creuziger

Sponsor: Naval Academy Research Council (OMN)

In March, 1995, Listeev, the famous television personality of the talk-show "TEMA" was shot in the stairwell of his apartment building. It is estimated that 5,000 people attended his funeral. His death sparked a campaign by President Boris Yeltsin to counter criminal activity in Moscow.

One year prior to this murder, Listeev hosted a show on life after death. In this program, he interviewed parapsychologists, parapsychics and people on the streets of Moscow. This show was one of many which address the involvement of many Russians today in mystical beliefs and the rituals surrounding mysticism, including extrasensory healing and astrology.

As is well known among social scientists, the religious views of people often reflect the needs of the society. At a time when political and economic chaos reigns, people are reacting in various ways: while some shun the human soul and take to crime, others join cult-like movements and immerse themselves in their mystical and religious beliefs.

This taking to extreme ways of life comes as no surprise, given the history of Russia. Many a writer and philosopher have described Russia as a country of extremes. However, the consequences for the future of Russia and her relationship with the world community may be grim. In the hopes of shedding light on the causes of social upheaval in Russia, the researcher discusses the connection between religious beliefs, notions of death, and attitudes towards crime. Whereas the media often portray Russia's problems hinging on lack of money, resources and a disorganized legal system, the researcher proposes that the seeming chaos lies on a deeper level. It is a result of a country suffering from her own soul. Unless this soul, this culture is given hope, the chaos will reign and development will be stifled.

This project is a joint effort with a political scientist from Portland State University, Dr. Rita Moore, to culminate in a book on "Mortality in Russia."

## **Text Comprehension and Foreign Language Reading: Theory and Practice. "Reading with a Purpose."**

Researcher: Assistant Professor Elizabeth M. Knutson

Sponsor: Naval Academy Research Council (OMN)

This study analyzes four basic components of the comprehension and interpretation process -- text, reader, task, and help. The analysis is based on research in a number of different disciplines on textuality and reading as a socio-cognitive practice. The first two

articles in the project focused on the issues of text difficulty and reader literacy. This article addresses the factors of task and purpose.

During summer 1994, the researcher completed bibliographic work on the concept of task as defined by

second language acquisition and applied linguistic studies. This bibliography includes research on task-based syllabi as well as on theories of academic literacy; research on pleasure reading; data-based studies of communicative tasks in classroom instruction, and research on the interdependence of reading and writing skills.

The article defines a number of real-world and academic reading purposes and highlights the benefits of a task approach in foreign language instruction. In contrast to an approach which prescribes an abstract set

of reading skills to be mastered, a task orientation to reading takes learners' needs as a point of departure; in other words, it is the intended use of texts which drives instruction. Purpose in the larger sense of reading across the curriculum -- from elementary levels of instruction up through such advanced level contexts as doctoral reading requirements -- is also discussed in this article. It is argued that all levels of instruction should be informed by a clear sense of learners' reading purposes and literacy needs.

## **Second Language Acquisition of English Reflexives by Japanese Speakers and Japanese Reflexive "Jibun" by English Speakers**

Researcher: Instructor Chiyo Myojin

Sponsor: Naval Academy Research Council (OMN)

The researcher investigates how native speakers of Japanese learning English acquire English reflexives and also how native speakers of English learning Japanese acquire the Japanese reflexive "Jibun" by extending Manzini and Wexler's (1987) parameter setting model for first language (L1) acquisition to second language (L2) acquisition.

The researcher, therefore, examines how Japanese learners of English and English learners of Japanese set values for the governing category parameters. The investigation continues to determine whether learners

observe the Subset Principle (Berwick 1985) and succeed in acquiring the correct L2 value, or whether they unsuccessfully transfer their L1 value to the L2 grammar, or adopt a value which is that of neither the L1 nor the L2. Even though the Subset Principle is not applicable to L2 acquisition, it seems that Universal Grammar (UG) (Chomsky 1981, 1986, 1989) is still applicable. Thus, this finding would support Manzini and Wexler's (1987) hypothesis that although the learning principles and UG are in different modules, they are interacting with each other.

## **Independent Research**

### **Women's Speech Patterns in Expressing Opinion: A Case Study in Spain**

Researcher: Associate Professor Penelope M. Bledsoe

The researcher continues this study as a part of an ongoing research project on women's speech in Spanish. It addresses the ways in which women express opinions on potentially sensitive topics -- topics which in some way involve them directly, either personally, professionally or culturally. The directness vs. indirectness of their responses and the linguistic structures used to express their opinions is the primary focus of the research.

It is hypothesized that women's speech in general is much more direct in Spain than it has been reported to be in the United States, both in requesting and expressing opinions. Studies of women's speech in the United States will be used as a source of comparison to gauge directness of response based on the occurrence of qualifiers, tag questions, hedges and impersonal

statements; therefore, the study is also cross-cultural.

The data for this research is gathered in Salamanca, Spain during two summer trips. The methodology is pre-arranged interview although the interviews often develop into informal conversations. Informants were middle-class, educated women with careers. They were told that the researcher was conducting linguistic research; however, the exact nature of the research was never revealed.

The results of the initial phases of this research were presented at the Northeast Conference of the American Association of Teachers of Spanish and Portuguese at Yale University, September, 1994. The researcher will continue her research on this topic this summer in Spain and will prepare an article for publication in the fall of 1995.

## **Perspectives on the Use of First Language (L1) in the Foreign Language Classroom**

Researchers: Associate Professor Penelope M. Bledsoe and  
Assistant Professor Elizabeth M. Knutson

The researchers are preparing a study on the perceived need by intermediate students and instructors of the use of the student's native language in the foreign language classroom.

They have researched the use of English in different teaching methods and language teaching approaches as a basis for this study. They developed student and instructor questionnaires to determine the contextual and affective factors contributing to this perceived need. The questionnaires were completed by all intermediate students of foreign languages at the U.S. Naval Academy and by all instructors of

intermediate language classes. In addition to the quantitative section of the questionnaire, a "comments" section was included for every major heading. Based on the statistical study and comments from the questionnaire, the researchers will record situations in which students' L1 is preferred and will determine if the preference is contextual or affective in nature.

The results of their research have been accepted for presentation at the Mountain Interstate Foreign Language Conference at Radford University in October, 1995. The presentation will be prepared for publication and forwarded to the Modern Language Journal.

## **Strategies for Cooperative Learning in the Intermediate Spanish Classroom at the United States Naval Academy**

Researchers: Associate Professor Penelope M. Bledsoe,  
Associate Professor Audrey Gaquin, and  
Associate Professor Elsa M. Gilmore

The researchers are preparing a session for presentation at the Annual Meeting of the American Association of Teachers of Spanish and Portuguese in San Diego, California, in August of 1995, on strategies for the incorporation and implementation of cooperative/collaborative learning activities in their intermediate Spanish classes at the U.S. Naval Academy. The linguistic skills involved in this study are listening comprehension (video lesson), reading comprehension, and speaking activities. Following the guidelines of Total Quality Education (TQE), students could choose to prepare the activity individually or in small groups; additionally, there were control and experimental sections. After students had accomplished their tasks, they were given quizzes to determine if group vs. individual work influenced mastery of the task and questionnaires to assess their personal response to the activity and self-evaluation of the

degree of success achieved in carrying out the activity.

Professor Bledsoe's responsibility was the speaking activity. Students divided themselves into small groups to negotiate, in Spanish, one common itinerary for visiting three Spanish cities. Authentic Spanish travel brochures were used for their research. Their negotiations were video-taped so that the instructor and students could evaluate their knowledge of the cities and especially, their proficiency in negotiating the task in Spanish. Evaluation sheets were prepared so that all students as well as the participating students and the instructor could evaluate the group work as well as each individual's participation in the task. Questionnaires were prepared to assess students' reaction to this type of collaborative speaking activity. The video tape as well as all authentic materials, evaluation materials and questionnaires and their findings will be shared with session participants.

## **Chantal Chawaf: Utopias and the Rewriting of Myths**

Researcher: Assistant Professor Marianne Bosshard

The purpose of this project is to analyze in the works of this author various versions of utopias that span her oeuvre on a thematic as well as a linguistic level. The result of this research project will be submitted for

publication in a collection of essays entitled "Réécriture des mythes: l'utopie au féminin," co-edited by Joëlle Cauville, Saint Mary's University, Halifax, and Metka Zupancic, University of Ottawa, Ottawa.

## **Wit and Satire in 17th Century Spanish Short Plays: Minority Groups**

Researcher: Associate Professor Maria E. Castro de Moux

This is a study of dramatic discourse and ethnic representation in 17th century Spanish short plays. The purpose of the research is to reveal existing stereotypical characterization of Gypsies, Blacks, Moors, Converted Jews and other groups. An important

aspect of the study is to determine the existence of critical attitudes in these plays counteracting the tendency towards ridiculing minority groups in the theater.

## **Lukacs after Glasnot**

Researcher: Professor Eva L. Corredor

This project was inspired by the ideological and political revolutions in Russia and Eastern Europe. It is based on a series of recorded interviews with ten eminent scholars of the United States, Europe and South America, who at the onset of their careers had been influenced by the theories of the Hungarian philosopher and literary critic Gyorgy Lukacs and since then have established themselves in their own right as major philosophers and theoreticians of culture and society. The book will assess the inspiration and seminal value of the works of Gyorgy Lukacs within the critical and philosophical discourse of the late twentieth century.

The manuscript is now nearly complete and has been contracted by a major university press. The introductory chapter will be added, the preliminary work for the index and the final editing done this summer.

The Academic Dean awarded the researcher a Recognition Grant in FY95 to match the publisher's advance toward the anticipated publication in the spring of 1996. This allowed the researcher to add a most valuable dimension to her study by conducting an interview with the South American critic, Roberto Schwarz.

## **Functional Critique**

Researcher: Professor Eva L. Corredor

This article was written in response to a question put forth by the Modern Language Association Division on Literary Criticism: "The Rhetorics of Criticism, Do They Work?" In her response, the researcher analyzes the direction contemporary critical rhetoric have taken over the last few decades which has often led to an a priori defeatist view of what criticism could and should accomplish. Referring to the Aristotelian claim for the effectiveness of art as an essential criterion for its legitimacy, the researcher demonstrates that a similar communicative ability can and should be required of

critical discourse. With the help of examples taken from contemporary critical works, the researcher establishes several points toward the practice of what she calls "Functional Critique," a criticism that has not surrendered its human and professional ethics to mere "jouissance" and visions of a "prisonhouse of language."

A paper based on this research was presented at the Congress of the Modern Language Association in San Diego, California, December 1994, funded by the U.S. Naval Academy.

## **A Slice of Russian Contemporary Lore: Strashilki and what They tell Us**

Researcher: Assistant Professor Clementine Creuziger

This article studies an often ignored aspect of folk lore, namely, child lore. Specifically, in this article the researcher analyzes Russian children's ghost stories as one might any oral narrative from both cultural and psychological perspectives. Those stories remain one of

the few traditions that, despite the social and political upheavals in Russia over the past century, have remained constant. While some may change slightly from one telling to the next, new ones being added and old ones forgotten, the tradition of "strashilki" among

children persists. While many scholars in the social sciences have identified the study of children's culture and lore as important to understand society as a whole, there has been a tendency to study children as simply acquiring culture from the adult world. This approach neglects the fact that children learn from each other, thereby maintaining and developing their own culture.

Moreover, since children also contribute to adult culture, a study of child culture would contribute to our understanding of cultures as a whole.

The article has been submitted to the journal "Elementa, UCLA" and is being considered for publication.

## **Living the Taboos of Russia: Orphans, Gangs and other Classics in the Making**

Researcher: Assistant Professor Clementine Creuziger

Children who experience a childhood as is idealized by Russian parents today can only be experienced by a privileged few. Lev Tolstoy's ideal, one that is often referred to in interviews when describing childhood, not only does not fully apply to any one family, but, moreover, completely passes by a whole sector of urban Russian society, often ignored in statistics and social studies. This ignored sector of Russian society has little hope of ever experiencing childhood in traditional Russian terms. It includes the unwanted children: children with both major or minor disabilities, children born to alcoholic and/or abusive parents, children whose parents simply cannot cope, children without parents or any combination thereof. It includes approximately 69,000 children, a number that is on the rise and of which 4,000 include children who are without parents. Such children are sent by the Russian government to any one of the variety of orphanages which has an available space.

This article describes the various options open to

orphans, their life and the taboos that surround them daily. In particular, the researcher describes the various orphanages, street life, the teachers and administrators' perspectives and the children's ideas on the subject through interviews, observation and linguistic analysis of pedagogical language used around children in the institutions. Because of the difficulties of the Russian orphanage system, which itself is jeopardized by the reigning social chaos in Russia, children are finding it more agreeable to join street gangs and to fend for themselves, as might adults. Only, these are not adults. These are children; they do not yet have the abilities that adults have to make their way in society. They can only survive in one profession: crime. In gangs, the children feel needed and loved by their peers. There is a closeness there, greater than any closeness experienced in institutions, and perhaps similar to what they envision a family to be like.

The article has been submitted and is being considered for publication by the journal "Childhood."

## **Diversity of American Culture**

Researcher: Assistant Professor Clementine Creuziger

This project on the culture of the Navy will be a chapter for a book entitled "Diversity of American Culture" (Larry Naylor ed.). The focus on the culture of the Navy is seen as separate from but overlapping with American culture. In this context, issues of gender and freedom of speech cannot be treated the same as they

might in every day American life. Through extensive interviews and research, this paper discusses the future of subcultures of women and homosexuals in the context of the culture of the Navy. It is the hope of the researcher that through this article, the general public will come to appreciate the Navy as a culture of its own.

## **My Sister the Midshipman**

Researcher: Assistant Professor Clementine Creuziger

This is a project requested by the Naval Institute Press to compose a children's book on the life of the midshipman. Designed for the elementary level (age 5-6) this story follows a young boy, Chester, as he visits the sister, Courtney, a midshipman, at the Naval

Academy. During his visit he notices the aspects exciting to a six year old boy such as the buildings, the ships, the sports and the marching. His enthusiasm is commented upon by his sister, who tells him how difficult some of the activities are. The book is designed



to introduce young children to the Naval Academy and to give little girls a means to see themselves as potential

officers by identifying themselves with Courtney.

## **Interactive Language Instruction and Authoring System (ILIAS)**

Researcher: Associate Professor William H. Fletcher

Building on work begun in collaboration with Southwest Texas State University under a grant from Fund for the Improvement of Post-Secondary Education (FIPSE), 1990-93, the researcher reprogrammed in Windows Visual Basic interactive video authoring lesson templates which he had originally developed to run under DOS. In program modules totaling over 15,000 lines of code, he has gone beyond the original functionality of the Macintosh-based Libra templates and his initial DOS implementation to provide a more author- and learner-friendly interface and to achieve a great degree of device independence through the Windows multimedia control interface (MCI), which supports a standard set of commands to drive almost any current model of videodisc player, video overlay card, sound card, or digital video capture and playback card.

In his complete revision, the researcher has emphasized ease of learning for novice authors while expanding flexibility and functionality of the authoring and lesson delivery programs. In developing the authoring interface, the researcher has drawn upon his experience with dozens of participants in interactive video workshops he has presented. ILIAS anticipates common author errors, issues appropriate warnings to the author, and intervenes to avoid program crashes if necessary. ILIAS features a non-linear approach to authoring. For example, an author can open several editor windows and work simultaneously on defining and transcribing video segments while editing items based on them. With the ILIAS design, creation and revision of lesson elements are both easy, which will encourage polishing, expansion, and adaptation of

lessons.

As of this writing (May 1995), the researcher has fully implemented and debugged these functions in the Windows version: videodisc segment editors; script editor and display window, with full support for hyperactive text (pop-up help with text, graphics and sound as well as linking to any supported event); message editor for preparation, feedback, and lesson help with full support for hyperactive text, graphics (cropped, scaled), and digital sound; editors for menus, multiple choice and checklist items (with hyperactive text, plus "balloon help" support for menus); student and author notepads with or without videodisc controller pad. Already prototyped in Visual Basic, but not yet compatible with current file formats are the following editors: link-event chain, binary checklist, and open-ended questions. Remaining to be reprogrammed from the DOS version are keyboard editor (e.g. for fonts with non-Roman characters in upper ASCII positions), dictionary builder and display window (with support for major non-English sorting orders), image capture to save video stills to file and create video icons, and icon assignment item editor.

In summer of 1995, the researcher will continue implementing the remaining item types and add a student accountability database engine. In addition, digital video support will be implemented to take advantage of the Language Studies Department's 36 new digital video delivery stations. Realistic goals appear to be full authoring support by fall of 1995, with lesson delivery support available by the spring term of 1996.

## **Peuples et langues de France: documents de minorités installées en France [Peoples and Languages in France: Documents from the Minority Cultures of France]**

Researcher: Associate Professor Audrey Gaquin

"Peuples et langues de France" is an anthology of documents from the seven regions of France whose inhabitants may be said to represent two cultures, that of the French nation, and the local culture, which is expressed in a language other than French, and which has a history and traditions other than those of

mainstream France. These seven regions, known in France as "minorités installées," include Alsace, the French Basque country, Brittany, North Catalonia, western Flanders (Westhoek), Corsica and Occitania. One section of the anthology is devoted to each of the seven minorities, and each section includes a historical

introduction, an interview with a minority leader, articles on political and economic issues concerning the region in question, sample lessons in the minority language, with translations into French, and information about customs, traditions and folk art in the region. After considerable delays in obtaining permission to reprint some articles and in preparing camera-ready copy, this anthology will be submitted to the University Press of America for publication in early June 1995.

The "minorités installées" have benefitted to some extent from recent legislation allowing greater regional autonomy in all of France, and removing some of the limits on freedom of expression of minorities, limits that had been in place in some cases since the Revolution of 1789. Autonomist groups garner varying degrees of support in the various regions, and their own degree of militancy varies, but their fundamental strength is reflected in the election of Max Simeoni, a Corsican autonomist, to the European Parliament, the inclusion of the Catalan language among the official

languages of the European Parliament, and the proliferation of ties among European regions that is beginning to result from the abolition of trade barriers at the end of 1992. At present, France is one of only two member nations that have not signed the Charter of Rights of Minorities of the Council of Europe, which would guarantee the rights of these minorities to state-supported instruction in their language and culture, state-supported cultural activities, and media time. This refusal to sign has intensified the sense of urgency of those minority members who wish to assure the survival of their language and culture.

In the United States, it is difficult to obtain even basic information about these minorities. "Peuples et langues de France" has been compiled in response to a growing need among Americans to recognize and understand this other side of French culture by making available to students, teachers and scholars primary source materials and background information on the seven minorities.

### **Elements of Theoretical Linguistics in Priscian's Institutiones**

Researcher: Associate Professor Audrey Gaquin

An examination of Priscian's Institutiones, the last great Roman grammatical treatise, shows that this work made available to Priscian's medieval successors certain fundamental theories on the nature of language. The theoretical material is found in the presentations of the different levels of language and the definitions of the noun and verb; these discussions stress the role of the communication context in governing language production, and affirm the predominance of the semantic component of language in determining

linguistic paradigms and practices. Priscian defines the semantic component as a set of semantic wholes, which are broken down into their component parts and matched with linguistic forms in order to produce language. This monograph, to be published by John Benjamins in their "Studies in the History of Linguistics" series, is a series of case studies of the development of Priscian's theory of semantic wholes in his theoretical discussions.

### **Marco Antonio de la Parra and the New Chilean Theatre**

Researcher: Associate Professor Elsa M. Gilmore

The researcher is continuing her long-term project on the work of this well-known and prolific Chilean dramatist. During 1994-1995, two of her articles on the subject have been published. One, focusing on the dramatic structure of Our Daily Secret Obscenity, appeared in the Fall 1994 issue of Latin American Theatre Review. A second article is included in the first de la Parra anthology to appear in English translation, published by Peter Lang.

During the past year, the researcher's attention has been drawn to two features which appear in varying

combinations in several de la Parra plays: a reference to tragedy and the theme of exile. Some of the research done in reference to these topics will assist the researcher when she serves as respondent to a session on the topic of exile in contemporary narrative at the Latin American Studies Association conference in September of 1995. All or some of this research will form the basis of an article which will be submitted for publication to an appropriate journal toward the end of 1995.

## **Cooperative Learning in the Intermediate Spanish Classroom**

Researcher: Associate Professor Elsa M. Gilmore

Together with two U.S. Naval Academy colleagues (Professors Bledsoe and Gaquin), the researcher has been investigating the implementation of cooperative learning research into the teaching of Intermediate Spanish I and II classes (a course the researcher coordinates) at the U.S. Naval Academy. The goals of this experiment have been to: improve learner motivation, and maximize recall of learned information. The researcher and her colleagues have prepared a variety of cooperative learning-based materials and activities which have been used this year in a few sections of FS201-202. These have been contrasted with non-cooperative learning oriented

activities in other sections of the course. Students in both the experimental and the control sections of the course have later been tested and surveyed to determine whether their learning or their motivation has been significantly affected by the pedagogical strategy utilized by the researchers.

This project will be the subject of a special interest session to be offered by the three researchers at the American Association of Teachers of Spanish and Portuguese in August, 1995. The theoretical background, context, materials, strategies, and results of the study will be presented to an audience composed of university and high school level Spanish teachers.

## **Schach von Wuthenow, Die Poggenpuhls, und Der Stechlin: Drei Fontanesche Kreuzzuege des Geistes [Three Fontanesque Crusades of the Spirit]**

Researcher: Associate Professor Sylvain Guarda

In research on Fontane much has been written on the leitmotif and the symbol as two shaping principles of Fontane's poetic imagination. However, no study has yet explored their meaningfulness in relationship with the death of several protagonists, which conveys a distinctively ritualistic character to Theodor Fontane's oeuvre. As a constant reminder, death lurks about through objects such as sepulchers, graves, and tombstones and, more importantly, through the puzzling suicide [not "Selbstmord" or "Suizid" but "Frei-tod" (free death) in German] or the seemingly natural death of one of the major protagonists.

A thorough textual analysis of three major play-novels, Schach von Wuthenow (1882), Die Poggenpuhls (1896), and Der Stechlin (1989) not only yields insight into the novelist's poetic imagination and individual creativity but also reveals that death constitutes the core of a commemorative ritual. Couched in the dialectics of the Old (Testament) and the New (Testament), this ritual enables the novelist to recapture his childhood by bridging time-realms (present and past), i.e. abrogating chronological time,

and to express his ambivalent stance toward 19th century Wilhelminian society. The play-novel Schach von Wuthenow proves most suited to demonstrate Fontane's journey into Hades and regression into his childhood. This ritual, an elaborate mnemonic device, is carried through many novels, including the last two, Die Poggenpuhls and Der Stechlin, in which the novelist no longer refers to his childhood but to his adolescent years. By contrasting the first with the last two works, the study brings to light Fontane's inner progression from the Old (Testament) to the New (Testament) world and, at the same time, his familiarity with Jewish theosophy and its rituals.

The final chapter of this book-length manuscript synoptically concludes that the last two novels are no longer to be viewed as realistic entertainment of the time, as many Fontane scholars have contended in recent years, but as two parts of a cabalistic thaumaturgy (Miracles) that commemorates and celebrates life. In tying Fontane's artistic ritual to Jewish theosophy, the study convincingly clears the novelist of any anti-semitism.

## **Perspectives on the Use of the First Language (L1) in the Foreign Language Classroom**

Researchers: Assistant Professor Elizabeth M. Knutson,  
and Associate Professor Penelope Bledsoe

This study is based on a survey of the views of instructors and students on the use of the L1 (English) and L2 (target language) in the intermediate level foreign language classroom. The study begins with an overview of the issue of English vs. target language usage in foreign language pedagogy, from the audio-lingual methodology of the 1960's to the proficiency-oriented and communicative approaches which

dominate today. The survey data represent views on L1 and L2 use on the part of instructors and students in French, Spanish, German, and Russian intermediate courses. Further bibliographic research was done on this project in the past year, and a paper proposal was accepted for the Mountain Interstate Foreign Language Conference at Radford University, Radford, Virginia, in October, 1995.

### **Illusion and Excess in *Splendeurs et misères des courtisanes***

Researcher: Assistant Professor Elizabeth M. Knutson

This article explores the narrative elements of story and discourse in Honoré de Balzac's well-known serial novel, *Splendeurs et misères des courtisanes*. This novel, like most nineteenth century French serial novels or "romans feuilletons," is characterized by force of illusion and primacy of plot. This is to say that story -- i.e. what happens, or more importantly, what will happen next -- is pre-eminent. At the same time, however, the narrator's discourse continually calls attention to narrating and reading modes in order to emphasize the dramatic nature of story events. This

discourse can be seen as a form of "noise" which disturbs narrative momentum and the transmission of plot. The concepts of "tellability" and "display text," defined by Mary Louise Pratt in *Toward a Speech Act Theory of Literary Discourse*, are invoked to describe the phatic nature of melodramatic discourse in general, and of Balzac's narration in particular. The article examines the potentially conflictual relationship between this discursive display and the exigencies of plot and illusion-building.

### **Writing as Thinking: Foreign Language Literature and the Pedagogy of Process**

Researcher: Assistant Professor Elizabeth M. Knutson

This project considers what the writing process movement in the field of English composition studies can contribute to the teaching of literature in a foreign language. The researcher first defines the basic principles of process theory, including perhaps most importantly the idea that writing can be used to generate as well as record thought, and then discusses the potential applications of these principles to advanced

level instruction in foreign language literature. Using specific examples from the field of French literature, the researcher discusses a number of classroom activities, including reading journals, in which writing as process rather than product can help students to generate, exchange, and refine their interpretations of literary texts.

### **The New Wave in Kazakh Cinema**

Researcher: Associate Professor Ludmila Z. Pruner

This is a book-length manuscript on new developments in the Russian speaking cinema of the former Soviet

Asian Republic. The book will focus on film productions since 1989.

### **Russian Culture, History and Civilization Reader: 19th and 20th Centuries**

Researcher: Associate Professor Ludmila Z. Pruner

This is a reader composed of original texts in Russian

with illustrations and exercises for the development of

the understanding of Russian culture and reading strategies in Russian for the Intermediate and Advanced

levels.

### **Juan de Mena's Laberinto de Fortuna: A Critical Transcription and Concordance of ESP.MS 299 of the Bibliothèque Nationale, Paris**

Researcher: Professor Gladys M. Rivera-La Scala

This work will be published by the Hispanic Seminary of Medieval Studies, University of Wisconsin-Madison, as part of their National Endowment for the Humanities-sponsored project, and the lexicon from the concordance will be included in the first Dictionary of Old Spanish, the first volumes of which are scheduled for dissemination in the early 1990's. This thirty-year

project, begun in the late 50's by Prof. Lloyd Kasten, has enjoyed yearly support from the National Endowment for the Humanities for over ten years and the expertise and work of at least two generations of scholars from the national and international communities.

### **Adjuvancy and Opposition: A Study of Supporting Roles/Women's Roles and Gender in Pedro Calderon de la Barca (1600-1681)**

Researcher: Professor Sharon Dahlgren Voros

This book-length study combines the methodology of semiotics with archival research on Pedro Calderon's secular and religious drama. While supporting or secondary and women's roles are often overlooked in drama studies, they provide keys for interpreting the playtext, since they complement and comment on the action of the main characters. Adjuvancy and opposition, terms from A.J. Greimas's semiotic model, imply actantial functions of characters of subordinate social rank, and hence often marginalized figures of Spanish society. The researcher presented two papers this year in connection with gender issues that evolve from study of feminine characterization and stage practice. The first, on Lope de Vega and the feminist debate in his play La prueba de los ingenios [The test of Wits], dated 1612, explores the philosophical underpinnings of the nature and character of women according to references in the text to Saint Thomas Aquinas and Aristotle. Lope refutes the received notion that women are biologically determined and have no

affinity for learning or intelligence. While debates on women were popular in the Renaissance, Lope's debate team privileges women, since his central female protagonist wins the contest against her male adversaries. The second paper, "Leonor de la Cueva Rewrites Lope de Vega: La firmeza en la ausencia and La corona merecida," shows how a woman dramatist, Leonor de la Cueva (d.1650), rewrote a similar theme from Lope's historical play on Alfonso VIII, for she rescripts the feminine roles as crucial to a renewed interpretation of woman. Both plays deal with the public recognition of royal wrong doing and point to the central issue of women and their position in court. Yet in both plays, women overcome the unsolicited advances of the king by means of their intelligence or wit and thus gain the moral high ground. This study, then, examines not only ways in which gender is articulated in the Spanish Golden Age, but seeks to evaluate the emergence of a feminine dramatic voice.

## **Publications**

BOSSHARD, Marianne, Assistant Professor, "Chantal Chawaf: le mythe de la femme comme initiatrice à la spiritualisation de la chair," *Mythes dans la littérature contemporaine d'expression française*, ed. Metka Zupancic, Québec: Les Éditions du Nordir, 1994, pp. 146-156.

In this article, the "myth of Eve" in the Old Testament and the "myth of the Courtesan" in the Sumerian Epic of Gilgamesh were analyzed. Both myths are discussed by Chawaf in her recent essay Le Corps et le verbe: la langue en sens inverse (1993). In her essay, the author has changed the original myths in order to emphasize

the role assumed by two female figures that played a maternal as well as a spiritual role in the early stages of human civilisation. The researcher analyzed this transformation in order to establish its particular paradigmatic significance in Chawaf's literary ethics.

BOSSHARD, Marianne, Assistant Professor, "Annie Cohen: à la recherche de l'eau, des origines, de la mémoire et du sens caché," in *L'Eau: source d'une écriture dans les littératures féminines francophones*, ed. Yolande Helm, New York: Peter Lang Publishing, 1995, pp. 146-165.

This study focuses on the poetics of "fluidity" present at the semantic and at the syntactic levels in three recent novels of this contemporary French woman author who, like Hélène Cixous, was born and raised in Algeria. The analysis was carried out in the context of Gaston Bachelard's, Gilbert Durand's and Luce Irigaray's theories on fluidity and on the imagery of water.

BOSSHARD, Marianne, Assistant Professor, "Chantal Chawaf: le magma maternel," *Revue Francophone* Vol. IX, no. 1 (Spring 1995), pp. 27-38.

This article focuses on the "regressive discourse" in the works of Chantal Chawaf and sheds new light on the complexity of the "maternal image" that leads to an identity crisis in many of Chawaf's protagonists. Some guidelines are offered as to the interpretation of the apparent impasses created by a writing that is both "regressive" and "redemptive" in its attempt to represent human beings in their physio-psychological and spiritual integrity.

BOSSHARD, Marianne, Assistant Professor, book review of Luce Irigaray's "Marine Lover of Friedrich Nietzsche", trans. Gillian C. Gill, *Studies in 20th Century Literature*, Vol. 18, no. 1 (Winter 1994), pp. 132-134.

This short essay reviews the recent translation of *Amante Marine* (1980), the fourth text in a long series of publications by the French feminist philosopher, psychoanalyst, linguist and writer Luce Irigaray. Engaging herself in a sympathetic yet deconstructive "dialogue" with subjects close to the heart of Nietzsche's philosophical reflections, Irigaray pursues a reading linked to the body, unveiling certain configurations that were silenced in Nietzsche's thought. The multiple themes the author touches on in this text center, essentially, around the topic of sexual difference, irreducible to the "Other" which, according to Irigaray, is the radical "un-thought-of" in all of Western intellectual and historical traditions.

BOSSHARD, Marianne, Assistant Professor, book

review of Nicolas Bréhal's "Les corps célestes", *The French Review*, Vol. 68, No. 6 (May 1995), pp. 1116-1117.

This short essay interprets Nicolas Bréhal's recent novel on the love-friendship ("l'amitié amoureuse") between two male protagonists in the light of research on contemporary masculine identity conducted by the French sociologist Elisabeth Badinter. Though a feminist reading of this text is no doubt possible, the review focuses on the extraordinary subtle manner in which Bréhal portrays a relationship between men that situates itself outside of homosexuality and the traditional, virile masculine friendship.

CASTRO DE MOUX, Maria E., Associate Professor, "El escritor, el místico y el loco;" "A Cirilo se le aparece Jesús," *Semiotica del Testo Místico. Atti del Congresso Internazionale*, ed. Guiseppe De Gennaro, L'Aquila: Edizioni del Gallo Cedrone, 1995, pp. 106-110.

In the essay, mystics and writers are compared as to their different reactions when standing on the threshold of the enlightened world of ideas. The short story, "A Cirilo se le aparece Jesús," narrates the mystical encounter of a Medieval, Catalan monk with Jesús.

CASTRO DE MOUX, Maria E., Associate Professor, "Canon de belleza femenina y estereotipos raciales en un entremes de Luis Quinones de Benavente," *Proceedings of the 13th International Golden Age Spanish Theatre Symposium (March 17-20, 1993) at the University of Texas, El Paso*, ed. Jose Luis Suarez Garcia, York, South Carolina: Spanish Literature Publications Company, 1995, pp. 51-62.

This is a study in the dramatic discourse of a short 1664 Spanish play, "El negrito hablador, y sin color anda la nina" (The Talkative Black Man and the Fair Lady) by Luis Quinones de Benavente. The importance of the beauty myth and of the position of free blacks is explored in the text. Gender and racial conflicts are resolved in the encounters between the various characters. Assimilation into the dominant group is supported in the play as a way of solving social tensions between races and gender.

CORREDOR, Eva L., Professor, book review of Susan Derwin's "The Ambivalence of Form: Lukacs, Freud, and the Novel", *Studies in 20th Century Literature*, Vol. 18, no. 2 (1993; published in Summer of 1994), pp. 180-182.

This is a critique of a study by Susan Derwin in which she provides an avowed "speculative" reading of Gyorgy Lukacs's *The Theory of the Novel* based almost

exclusively on Lukacs's youthful Kierkegaardian negativism. In the subsequent discussion of Sigmund Freud's Totem and Taboo, the author attempts to establish a link between Lukacs and Freud through the latter's stress on the importance of the concept of unity. While her readings of four realist novels are lively and imaginative, in their theoretical suppositions they add up to a Freudian misreading of Lukacs. Her attempt at understanding in the end collapses into a total méconnaissance by which she implicates Lukacs, quite indiscriminately, in a phallic game of critical "jouissance."

GILMORE, Elsa, M., Associate Professor, "Old Cuisine, New Cuisine: de la Parra's The Raw, the Cooked, and the Rotten," *The Theatre of Marco Antonio de la Parra*, ed. Charles Thomas, New York: Peter Lang, 1995, pp. 237-253.

This article focuses on the relationship that links The Raw, the Cooked, and the Rotten, by playwright Marco Antonio de la Parra, and the historic transformations which took place in his native Chile from the late 1960's until 1973. Poised on the brink of a military dictatorship (which in fact banned the play only days before its scheduled debut in 1973), the text is shown to share the premises of Walter Benjamin's theory of history: the assumption that ethical "progress" does not occur spontaneously throughout history, and the admonition to artists to be the moral guardians of society, unveiling and condemning injustice.

GILMORE, Elsa M., Associate Professor, "Contigüidad y ambigüedad en La secreta obscenidad de cada día," *Latin American Theatre Review* (Fall 1994), pp. 7-16.

Marco Antonio de la Parra's theatre, like so much drama produced in Latin America today, is marked by a regret over the loss of modern values and of a post-modern "écriture." In Our Daily Secret Obscenity, de la Parra depicts this dilemma through plot structure, language registers, referential codes, and particularly through the multiple identities of the two characters who variously appear on stage as icons of modern Western thought (Karl Marx and Sigmund Freud), as symbols of modernity's self-annihilation (two terrorists) and as the detritus of post-modern society (a pair of "flashers"). Gilles Deleuze and Felix Guattari's classic study Anti-Oedipus provides the theoretical foundation for the analysis, which brings to bear political, psychoanalytical, and linguistic elements, and focuses on their points of intersection and overlap.

KNUTSON, Elizabeth M., Assistant Professor, Michael C. MacQueen, U.S. Department of Justice, co-author "Regional Identity and German Policy in Alsace

1940-1944," *Contemporary French Civilization*, Vol. 18, no. 2 (1994), pp. 151-166.

The central goal of German policy at the time of the annexation of Alsace in 1940 was the rapid reintegration of the Alsatian population into the larger German community. This study focuses on the Germans' efforts to assimilate Alsace, particularly with respect to policies on language and culture, and on the Alsations' resistance to cultural and linguistic absorption. The study is based on recent secondary scholarship and on primary source materials, consisting of reports and documents of the German civil administration and secret police of the period.

MYOJIN, Chiyo, Instructor, "I am teaching Japanese at the U.S. Naval Academy," *Asahi Weekly Magazine*, August 21, 1994, pp. 10-11.

This article describes what has contributed to the author's interest in learning English and linguistics in the USA. It also explains her experience of studying and teaching at Georgetown University for seven years after she came to the USA in 1984. Subsequently, the article explains what brought her to teach Japanese at the USNA and how she has been teaching there comparing this experience with civilian universities. It states furthermore what kind of responsibilities she has teaching Japanese to future naval officers and what kind of goals she has been pursuing by teaching her students.

MYOJIN, Chiyo, Instructor, "Woman Series: A Japanese Instructor at the U.S. Naval Academy," *Shuukan Shinchoo*, Shinchoosha, October 27, 1994, pp. 163-165.

This article describes the author's motivation for teaching Japanese at the U.S. Naval Academy as well as her experience teaching at schools in Japan and at Georgetown University before she started teaching at the USNA in 1991.

PRUNER, Ludmila Z., Associate Professor, book review of Anna Lawton's "Kinoglasnost: Soviet Cinema in Our Time," *Slavic and East European Journal*, Volume 38, no. 4 (Winter 1994), pp. 699-701.

The analysis presented in the book relates to on stage and behind the scene developments during the last years of Soviet cinema and the existence of centralized "Goskino." This information will be welcomed by general readers as well as cinema researchers.

PRUNER, Ludmila Z., Associate Professor, book review of A. Horton and M. Brashinsky's "The Zero

Hour: Glasnost and Soviet Cinema in Transition," *Slavic and East European Journal*, Volume 38, no. 2 (Summer 1994), pp. 389-390.

This book review article analyzes the first text on glasnost cinema both documentary and feature films.

VOROS, Sharon D., Professor, "The Feminine Adjuvant: Towards a Semiotics of Calderonian Plot Dynamics," in *The Golden Age Comedia: Text, Theory, and Performance in Honor of Vern G. Williamsen*, eds. Charles Ganelin and Howard Mancing, West Lafayette, Indiana: Purdue University Press, 1994, pp. 324-341.

This article employs A.J. Greimas' notion of adjuvancy in connection with Thomas Pavel's model for plot dynamics in an analysis of four feminine supporting roles in plays of Pedro Calderon de la Barca (d. 1681): Fénix in El principe constante (The Constant Prince), a religious drama; and Medea, Ariadne and Deyanira in Los tres mayores prodigios (The Three Great Prodigies), a mythological play. These roles not only include the traditional feminine helpmates, but involve

supporting male exploits in which women acquire heroic attributes themselves. Feminine adjuvancy, involving the helpers as actants, has often been undervalued or overlooked even by current scholarship. This study uses semiotics to define these roles precisely, using the theories of the French anthropologist Claude Lévi-Strauss, as the "mediated" and "unmediated" adjuvants. Mediation means that objects, special powers, or people intervene to help the feminine adjuvant perform her task. The mythological play involves mediated adjuvancy, while the religious drama employs unmediated adjuvancy, underscoring the notion of free will and Christian redemption; assistance is rendered by the feminine character out of her own spiritual goodness. The researcher also identifies plot dynamics and the role of the feminine adjuvant in the structure of decision making that determines dramatic structure and final outcome. Calderon's portrayal of feminine roles, even those that are secondary to the main dramatic discourse, show a sensitivity and depth that theoretical approaches can elucidate.

## Presentations

BLEDSON, Penelope M., Associate Professor, "Women's Speech Patterns in Expressing Opinion in Spanish: A Case Study in Spain," American Association of Teachers of Spanish and Portuguese, Yale University, September 1995.

BOSSHARD, Marianne, Assistant Professor, "Marie Redonnet et Chantal Chawaf: Divergences et convergences dans deux écritures engagées," International Colloquium on Contemporary Women's Literature, in France, Québec and Acadia, since 1986, Dalhousie University, Halifax, Nova Scotia, Canada, 29 September - 1 October, 1994.

CASTRO DE MOUX, Maria E., Associate Professor, "Una caricatura de la corte: nobleza y realeza en el Entremes del Conde Alarcos," Congreso Internacional sobre Mira de Amescua y el Teatro Espanol del siglo XVII, University of Granada, Spain, 28 October 1994.

CASTRO DE MOUX, Maria E., Associate Professor, "Duality in Calderon's La estatua de Prometeo: Astral Myths and Emblems," Fifteenth Golden Age Theater Symposium, University of Texas, El Paso, Texas, 8 March 1995.

CORREDOR, Eva L., Professor, "Functional Critique," Divisional Session on Literary Criticism, Congress of Modern Language Association of America, San Diego, CA, 27-30 December 1994.

CREUZIGER, Clementine G.K., Assistant Professor, "Tolstoy and 20th Century Russian Education," NEMLA Conference, Boston, Massachusetts, 1 April, 1995.

CREUZIGER, Clementine G.K., Assistant Professor, "Orphans and Street Gangs in Russia Today," Meeting Project Friendship of Annapolis and St. John's College Russian Club, Annapolis, Maryland, 19 March 1995.

CREUZIGER, Clementine G.K., Assistant Professor, "Living the Taboos: Orphans of Modern Russia," Annual Conference of the American Anthropological Association, Atlanta, Georgia, 30 November 1994.

CREUZIGER, Clementine G.K., Assistant Professor, "Living in Russia: Changes in the Last Four Years," Conference by the American Council of Teachers of Russian, Washington D.C., 1 September 1994.

FLETCHER, William H., Associate Professor, "Choosing and Using Authentic Video for English Language Instruction," two-day workshop conducted in English and Spanish, Benemerita Universidad Autonoma de Puebla, Puebla, Mexico, 28-29 October 1994.

GAQUIN, Audrey, Associate Professor, "France's Regional Languages in the New Europe," American Association of Teachers of French (AATF) Annual



Convention, Quebec City, 20 July 1994.

GILMORE, Elsa M., Associate Professor, "Textual Distortions in Montes-Huidobro's Eyes to be Blind With," American Association of Teachers of Spanish and Portuguese, Philadelphia, PA, 10 August 1994.

GILMORE, Elsa M., Associate Professor, "What Do Women Want? Gabriele Roepke's The White Butterfly," A Stage of Their Own Conference on Women in Spanish and Spanish-American Theatre, University of Cincinnati, Cincinnati, OH, 5 October, 1994.

KNUTSON, Elizabeth M., Assistant Professor, "Proficiency-based Instruction at the Intermediate and Advanced Levels," Faculty Workshop for Departments of Foreign Languages and Literatures at Connecticut College, New London, Connecticut, 23 September 1994.

PRUNER, Ludmila Z., Associate Professor, "The Other Cinemas: Between Illusion and Reflexivity," 1994 National Convention of the American Association for the Advancement of Slavic Studies, Philadelphia, PA,

25 November 1994.

PRUNER, Ludmila Z., Associate Professor, "The Anatomy of Deception on the Screen: Encounters with Kira Muratova," 1994 National Convention of the American Association of Teachers of Slavic and East European Languages, 29 December, 1994.

PRUNER, Ludmila Z., Associate Professor, "How the Post-Soviet Cinema is Forged," International Film Conference, New Orleans, LA, 14 February 1995.

VOROS, Sharon D., Professor, "Lope de Vega's La prueba de los ingenio (The Test of Wits) and the Feminist Debate," Fifteenth Annual International Golden Age Spanish Drama Symposium, The University of Texas at El Paso, El Paso, Texas, 8-11 March, 1995

VOROS, Sharon D., Professor, "Leonor de la Cueva Rewrites Lope de Vega: The Subversion of Silence in La firmeza en la ausencia (Firmness in Absence) and La corona merecida (Worthy of the Crown)," Northeast Modern Language Association, Boston, Massachusetts, 30 March-1 April, 1995.

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# Political Science

Professor Stephen E. Frantzich  
Chair

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**P**olitical science is a multi-faceted discipline focusing on divergent geographical regions and a variety of human behaviors. Research activity in the Political Science Department reflects this range of endeavor. Methodologically our faculty is also diverse. One can find examples of inductive analysis, empirical data manipulation, case studies, documentary analysis and field experimentation. In keeping with the emerging information superhighway, many of our faculty have become facile in using computer databases and the Internet to support their research. Political Science faculty have published widely this year in numerous formats and have actively been sought out for professional presentations. Convinced of the value of independent research, our faculty have sponsored a large number of student research projects.

The nine books published by departmental faculty reflect the diversity of the discipline. Two textbooks (one on Congress and one on public policy) focused on aspects of American Politics. An edited international relations text has become a standard in its field. One specialized book on ethnic conflict represents an international bent solidifying the author's recognition as an international expert in the field. The annual reference guide to the United Nations has been established as a standard reference for both academics and foreign policy practitioners. Another series of books represent our faculty's commitment to improving knowledge

about teaching methodology. A number of additional book length projects are in preparation. Above and beyond publishing books, departmental faculty have represented their competence through a series of journal publications and conference presentations.

Aside from publishing, research support serves as a measure of outside validation of faculty efforts. This year departmental faculty received external research funding from sources as diverse as the U.S. Congress Office of Technology Assessment, American Enterprise Institute, Mobil Shipping and Transportation Company, Darken Center, Harvard University, U.S. State Department, United States Air Force, and a variety of publishers.

Working closely with faculty advisors, five students completed extensive honors theses and four others did independent research projects. These projects allowed students to build on their regular course work and participate in the true research experience.

A perusal of departmental research efforts indicates extensive activity on the part of all members of the faculty. Those with less extensive research output this year have other projects in the pipeline. Research is alive and well in the Department of Political Science. The knowledge and excitement of research spills over to the classroom where faculty can use their research to educate and stimulate students.

## Sponsored Research

### Technological Innovation in Government: The Impossible Dream?

Researcher: Professor Stephen E. Frantzich

Sponsors: U.S. Congress, Office of Technology Assessment;  
American Enterprise Institute; Joint Committee on the Reform of Congress

New technologies provide significant challenges and opportunities for political institutions such as Congress. Governmental institutions face a particular challenge when attempting to innovate. Starting from the literature on technological innovation, this research attempts to assess the unique characteristics of governmental institutions which either facilitate or retard innovation. The research involves evaluating

both American and European literature, as well as carrying out over thirty interviews with government employees. The research has resulted in three technical reports, a convention paper, and a book chapter that will be published in an international collection of essays in 1996.

## **The Private Affairs of Public Affairs: The C-SPAN Revolution**

Researcher: Professor Stephen E. Frantzich

Sponsors: The Dirksen Center, Harvard University, (Barone Shornstein Center),  
University of Oklahoma Press, USNA Faculty Recognition Grant

Using the literature on technological innovation, organizational behavior, and political communications, this research is designed to outline the history, operations and implications of C-SPAN for the political system. Based on over 60 interviews, access to internal C-SPAN documents, and an assessment of polling and other empirical data, this study is the first

comprehensive analysis of a niche market public affairs network such as C-SPAN. the research has already resulted in two papers and has been accepted for publication by the University of Oklahoma Press. Professor Frantzich is the prime investigator, and has been aided by Dr. John Sullivan of the University of Virginia.

## **American Council on Education National Norms Study of College Norms**

Researchers: Assistant Professor Eloise Malone  
and Professor Charles Cochran

Sponsor: Naval Academy Research Council

This is an ongoing study of American college students' attitudes and behaviors begun in the late 1960s. The data sets have been recomputed as SPSSX system files and moved to the SUN system in Computer Services. Professors Malone and Cochran collected and analyzed data from the 1991 plebe class and prepared a summary report of findings to the Dean of Admissions, Director of Institutional Research, and Academic Dean. They plan to extend the Analysis of the American Council on Education (ACE) survey results by comparing them

with the "Defining Issues Test" (DIT).

The study offers the opportunity to compare midshipmen attitudes and characteristics with national norms of college freshmen. No particular investigation of a military educational context and Cooperative Institutional Research Program (CIRP) responses appears in the literature. Such comparisons provide valuable conclusions to students of political socialization patterns, educational trends, and leadership studies.

## **Foreign and Domestic Implications of Rising Nationalism in Russia**

Researcher: Professor Arthur Rachwald

Sponsor: U.S. State Department

This study is designed to examine the origins and the political content of the rising nationalism in post-Soviet Russia. Among the numerous and ominous manifestations of the nationalistic extremism in Russia are the popularity of Mr. Vladimir Zhirinovsky's idea of expansion to the Indian Ocean, restoration of the Soviet

Empire, and division of Europe between Russia and Germany. The purpose of Dr. Rachwald's research is to systematically study contemporary Russian nationalism and to publish the results in the form of a monogram or a book chapter. The study is still in a research stage, and it should be completed before the summer of 1996.

## **Future U.S. Political/Military Options for Northeast Asia: Counterproliferation-Nonproliferation**

Researcher: Professor Robert Rau

Sponsor: Institute for National Security Studies,  
United States Air Force

## **Gauging and Explaining the Success Rate of Sexual Harassment Plaintiffs**

Researcher: Assistant Professor Priscilla Zotti  
Sponsor: Naval Academy Research Council

## **Independent Research**

### **Continuation of Replication of National Norm Studies: U.S. Naval Academy Midshipmen Attitudes and Behaviors**

Researchers: Professor Charles L. Cochran, and Assistant Professor Eloise Malone

This is an ongoing study of American College Students' attitudes and behaviors begun in the late 1960s. The data sets have been recompiled as SPSSX system files and moved to the SUN system in computer services. Professors Cochran and Malone administered the survey in summer 1994 and are currently compiling and summarizing the data. They plan to extend the analysis of ACE survey results by comparing them with the

"Defining Issues Test." The study offers the opportunity to compare midshipmen attitudes and characteristics with national norms of college freshmen. No particular investigation of a military educational context and CIRP responses appears in the literature. Such comparisons provide valuable conclusions to students of political socialization patterns, educational trends, and leadership studies.

### **Central and East European Foreign Affairs**

Researcher: Professor Arthur Rachwald

This book length study will analyze foreign and security policies of Central and East Europe since 1989. The breakdown of the Warsaw Pact of the Soviet Union has enabled these nations to pursue their own national

interests for the first time since the end of World War II. This study is in a planning stage, and should be completed at the end of 1997.

### **The Emergence of a Party System in Russia**

Researcher: Professor Arthur Rachwald

The 1994 parliamentary elections in Russia were unique in Russian history. The vote was split primarily among eight political parties, some of which did not even exist until a few months before. Not only were the parties new, but the electoral mechanisms themselves were novel in that they were designed to encourage party

formation. This study focused on the newly formed parties in Russia, and on the emergence of a democratic state structure that incorporates political parties as one important element of the relationship between those governing and those governed.

### **Looking West**

Researcher: Professor Arthur Rachwald

This chapter of a book on Poland's foreign policy explores Polish aspirations to become a member of the Western community of nations. More specifically, Poland is striving for full membership in the European

Union and NATO, to achieve a permanent place in the Western World to assure that the country's economic and political systems, cultural and moral values are parallel to the Western part of the European continent.

At the same time, the country is becoming an indispensable constituent of the European security

system, contributing to the end of the division of Europe, as produced by the Yalta Accord of 1945.

## **The Structure of International Events-- Testing a Theoretic Model of World Political Behavior**

Researcher: Professor Rodney G. Tomlinson

This research is ongoing and focuses primarily on maintaining the World Events/Interaction Survey data files and then testing the behavioral model with the new data. During the summer of 1994 and then early winter 1994/95, additional data (through 11/94) were collected. This continuing effort led to an article in the *Journal of Ethno-Development*.

This research has gained added impetus with the advent of the Clinton administration, where new emphasis has been added to crisis early warning and increased intelligence funding. Hence the rules and norms that circumscribe international political behavior become increasingly important as devices for detecting impending difficult situations. The vast majority of

national leaders conform to customs of diplomatic practice. They tend to ascribe to similar perceptual constructs as to the meaning and impact of certain actions. This case study and analysis effort identified patterns of conduct indicative of stable, problem solving relationships and found evidence to characterize non-problem solving behavior. The presence or absence of the patterns provide clues to the general outcome of a situational issue. These findings independently corroborate work of other scholars, thereby leading credence to some general theories of conflict.

## **Research Course Projects**

### **Can States Deal with Major Social Problems?**

Researcher: Midshipman 1/C Mike Hassenger

Adviser: Professor Charles L. Cochran

In recent years, social problems have developed within the United States that have demanded governmental attention. One such problem has been health care. Beyond debating what should be done to deal with the social problems resulting from inadequate health care, politicians and concerned parties have discussed the ability of states to deal with major social questions, such as health care.

This paper first examines the Oregon health reform plan as a case study in an effort to examine in practice

the benefits and problems of state health care reform. Next, state health care reform in general is considered. Finally, some of the dynamics of the American federal system are inspected.

In conclusion, states are deemed capably suited to deal with localized issues requiring a sense of "community" to generate political will. However, the ability of states to operate highly expensive social programs is held dubious at best.

### **The CIA and the Media: Feasibility of Increased Information Security in the United States**

Researcher: Midshipman 1/C David Burke

Adviser: Professor Charles L. Cochran

The United States government's intelligence communities are constantly struggling with methods to improve the security of classified information. This is a difficult task because of the large amount of material held by it. At the same time, the media seeks to keep

the American public informed about what is happening inside the government. While both organizations have legitimate goals, conflicts tend to develop because the two entities are doing opposite things. This has resulted in disputes between the two which are difficult

problems to solve.

This paper contrasts the two positions in order to determine whether a working relationship can be defined so it neither hinders the media's First Amendment rights, nor affects existing intelligence operations. The positions are compared philosophically, to begin with, and the precedent set by the Founding Fathers follows. The conflict between the media and the government is then demonstrated through definitions and examples. Behaviors are exhibited by both government officials and journalists that contribute

to this problem. Related laws and Supreme Court interpretations are then used to point out that American laws are insufficient in dealing with the problem. Several solutions are offered, including the examples of other countries, but the option to create a law that restricts the media's right to publish is not workable. Instead, the author recommends that the government work to keep classified material more secure, and work with the media rather than against it. In the end, the unauthorized publication of national security information will be reduced.

## **The Impact of Motion Pictures on the American Political Culture**

Researcher: Midshipman 1/C Poul Jensen  
Adviser: Professor Stephen Frantzich

This paper discusses film's impact on the American political culture. The format of the paper consists of two distinct parts. The first portion gives a general overview of the purpose of motion pictures and their role as a communicator and form of entertainment. It examines the political and monetary impact of the Hollywood film industry. The first part also surveys several research studies done to determine the retention rates for movies as well as review and summarize several studies conducted to determine motion picture's influence on the audiences' values, conduct, and behavior. The second portion of the paper discusses the results of a content analysis study used to determine the

relationship between American political public opinion and the content of American political films. First, public opinion data and trends were collected from the last thirty years. Then, six Hollywood movies were carefully picked from this same time period and then analyzed for the frequency and type of depictions of certain chosen political issues. Comparisons and conclusions were then drawn that showed a positive relationship between the two variables. However, films tended to oversimplify the complexities of the political system and resort to overwhelmingly negative stereotypes of the political system.

## **Uganda under Idi Amin: Ethnic Conflict or Genocide?**

Researcher: Midshipman 1/C Matthew Eby  
Adviser: Associate Professor Barbara Harff

Midshipman Eby presents a good understanding of the conflict literature during the course of the semester. His paper utilized a conflict model of genocide to

explain the murder and disappearance of thousands during Amin's rule. By doing so, he determined that the phenomena in question was geno/politicide.

## **Nuclear Proliferation: Factors, Reasons, and Remedies**

Researcher: Midshipman 1/C Paul H. Wingart  
Adviser: Professor Helen E. Purkitt

This project was completed in coordination with the Naval Academy's Political Science Department as partial fulfillment of an honors project. The project deals with nuclear proliferation and the factors that influence a nation's decision to pursue nuclear weapons.

During the Cold War, strategies such as deterrence and mutually assured destruction (MAD) applied to nations in their attempts to attain nuclear weapons. With the end of the Cold War, these theories have also fallen by the wayside. Now, no real nuclear proliferation theory exists. After a survey of literature,

the author draws four propositions which are believed to have an effect upon nuclear proliferation. These propositions can be broken down into subcategories, called factors. By using an exploratory inductive research design, the author attempts to show which factors, over time, play a role in nuclear proliferation.

The two cases which are studied in this research project include Israel and South Africa. For each case, an in-depth nuclear timeline was established. Also, a timeline covering domestic, regional, and international events involving each nation was produced. By

comparing the events which occurred in each timeline, the author was able to distinguish which factors played roles in nuclear weapons development over different time periods. A chart was developed for each nation listing the results of each case study.

From the results, the author distinguishes similarities and differences between South Africa's and Israel's nuclear programs. From this comparison, conclusions were drawn on what factors were most important in developing nuclear weapons.

## **Public Opinion, Mass Media, and Foreign Policy**

Researcher: Midshipman 1/C Boris Shapiro  
Adviser: Professor Helen E. Purkitt

This is an exploratory research project on the relationship between public opinion and U.S. foreign policy decisions. The major empirical hypothesis is that the American government is more likely to commit military forces abroad when there is a high degree of public support for the deployment of military forces abroad. Mass public opinion affects U.S. military involvements abroad by influencing the body of the U.S. government which is responsible for making those decisions; and the media is an intervening variable which influences public opinion and the President's approval rating.

The research begins with a survey of literature that has dealt with the role of public opinion and foreign policy. The early research, by such pioneers as Gabriel Almond and James Rosenau, shows that public opinion has a limited and very volatile effect on policy. However, more current studies show a more defined correlation and greater impact of public opinion and the media coverage of a foreign conflict on the formulation of policy.

The type of design logic used is a case study which examines the media coverage, Presidential support, and

the public opinion concerning the crisis in Bosnia. The data collection procedures are a content analysis and data analysis. The data analysis consists of Gallup Poll data concerning the question over time of whether or not the person surveyed approves or disapproves of the way the President is handling his job. The content analysis involves the coding of the *New York Times* articles that deal with the subject of Bosnia from July 1991 to December 1994. The coding revealed the frequency of articles over time that appeared on Bosnia and a thematic coding showed the breakdown of which of those articles could be classified under the four major themes of diplomacy, military conflict, human interest, and U.S. action.

The research found that the amount and type of media coverage that was coded was not enough to prompt public opinion to put pressure on the President to commit troops abroad. The evidence is contrary to the hypothesis which would conclude that the U.S. would intervene. In the case study of Bosnia, public opinion and press coverage did not cause the U.S. to take a more active role in the crisis and did not have a causal effect on foreign policy.

## **The Future Role of NATO in European Security**

Researcher: Midshipman 1/C Scott Kremier  
Adviser: Professor Arthur R. Rachwald

This study examines the future of NATO in the European security landscape. There are three primary threats facing Europe in the near future: nationalism, ethnic conflicts, and the resurgent Russia and Germany. But, there are also four basic security structures in existence to address these threats: NATO, the West European Union, the Organization of Security and Cooperation in Europe, and the European Union. Analysis of the capabilities of the separate structures

reveals that NATO will remain the most effective security structure for meeting the changing risks to stability.

The study concludes that NATO will continue to serve as the dominant security organization in Europe. However, a strong European pillar, including admission of the Central European nations, must emerge within NATO if it is to survive as a viable alliance.

## **Russia's Transition to a Free-Market Economy. A Study in the Politics Surrounding Foreign Investment in Russia in the Post-Soviet Era**

Researcher: Midshipman 1/C K. Quinn Fionda  
Adviser: Professor Arthur R. Rachwald

As political reforms were slow to come to Russia after the fall of the Soviet Union, the Russian economy was unable to adopt to free market conditions as some of the Central and East European nations managed to accomplish. This "political stall" has left anxious investors skeptical about any future investments and

thus inhibited the efforts to move Russia away from a centralized, command model. Additionally, the "old guard" worked hard to preserve some of the rigid forms of governmental interference, generating a high level of political risk for foreign investments in Russia.

## **Korean Unification: Following the German Path?**

Researcher: Midshipman 1/C Bradley N. Rosen  
Adviser: Professor Robert L. Rau

With the demise of Communism, in the late 1980s, and the unification of East And West Germany, in 1991, hopes for Korean unification appeared somewhat brighter. Unfortunately, for a variety of reasons, the Republic of Korea and the Democratic People's Republic of Korea are still separate states. This paper attempts to analyze the prospects for Korean reunification in the light of the German experience.

The body of the paper includes the historical aspects of Korean division, compares the German and Korean situation and describes the various lessons learned from the German experience. The final portion of the paper discusses the implications of Korean reunification for the United States, Northeast Asia and the rest of the world.

## **Publications**

CURTIS, Willie, Associate Professor, "The Inevitable Slide into Coercive Peacemaking: The U.S. Role in the New World Order," *Defense Analysis*, (December 1994), pp. 305-321.

Given the changing nature of conflict in the new world order, traditional peacekeeping methods are ill-equipped to cope with the brutal ethnic, religious, social, cultural, linguistic, intrastate and communal strife confronting the international community today. The public's perception of the meaning of peacekeeping has changed significantly and new terms such as peacemaking, peace-enforcement and post-conflict peace-building best describe the expanding role of the United Nations. The question for U.S. defense planners is what role should the military play in support of U.N. operations. This article argues that while the traditional role of peacekeeping is still a legitimate function for the U.S. military in the post-Cold War era, a thorough assessment of the potential problems and cost should be undertaken before a large scale commitment of U.S. forces to peacemaking, peace-enforcement, and peace-building missions. Without a clear national policy there

is a high probability of an inevitable slide into coercive peacemaking.

CURTIS, Willie, Associate Professor, "Maneuvering in the Grey Zone: The Gap Between Traditional Peacekeeping, Warfighting, Peacemaking, Peace Enforcement, and Post-Conflict Peace-Building," *Peacemaking, Peacekeeping, & Coalition Warfare: The Future Role of the United Nations*, Washington: National Defense University Press (1994), pp. 175-183.

Lacking a clearly articulated national policy on operating in the gray zone of peacemaking, peace-enforcement and post-conflict peace-building, the United States and the United Nations risk an inevitable slide from traditional peacekeeping into coercive peacemaking. Coercive peacemaking is defined as forcible actions to include military action, to impose peace between unwilling belligerents. There is a role for the U.S. military in support of U.N. peace operations, however, only with a clearly articulated national policy from the Clinton Administration can the military leadership develop military objectives that will



permit them to structure the forces suitable for successful operations in the gray zone between traditional peacekeeping and warfighting.

FRANTZICH, Stephen E., Professor, and Steven Schier, "Congress: Games and Strategies," Dubuque, IA: Brown and Benchmark, 1995.

A comprehensive and up-to-date undergraduate textbook designed around the game analogy for studying Congress. The text includes traditional materials as well as a wide variety of pedagogical enhancements such as "The Members Speak," boxes and detailed case studies.

FRANTZICH, Stephen E., Professor, and Steven Schier. "Congress: Games and Strategies--Instructor's Guide," Dubuque, IA: Brown and Benchmark, 1995.

An instructor's guide designed to enhance the teaching of Congress. Special emphasis is placed on the use of video materials and methods of using the Internet and commercial databases for the analysis of Congress.

FRANTZICH, Stephen E., Professor, "Congressional Database Analysis Package, 2nd Edition," Hialeah, Florida: National Planning and Consulting Corporation, 1995.

A book of student exercises to accompany the Congressional Database. Exercises are key to major topics in American government and Congress courses. The exercises are designed to both introduce students to substantive material and to familiarize them with the procedures of empirical analysis.

FRANTZICH, Stephen E., Professor, (contributing author), "Instructor's Guide to the Lincoln-Douglas Debates," C-SPAN, 1995.

A series of classroom exercises for political science courses using the reenactments of the Lincoln-Douglas Debates as broadcast on C-SPAN. The author was one of three coordinators for a three day seminar of college faculty which jointly created the exercises.

FRANTZICH, Stephen E., Professor, "Storming Washington: An Intern's Guide to National Government, 4th Edition," Washington: American Political Science Association, 1994.

A hands-on guide to student internships and internship programs in Washington D.C. This popular 82 page monograph is now in its 4th edition and serves as an orientation to the process of securing and enhancing an

academic internship.

FRANTZICH, Stephen E., Professor, "Tapping the Internet for the Study of Congress," *Legislative Studies Newsletter*, Fall, 1995.

An invited article on the emerging computerized sources for studying the U.S. Congress.

HARFF, Barbara, Associate Professor, and T.R. Gurr, "Ethnic Conflict in World Politics," Boulder, Colorado: Westview Press, August 1994, pp. 200.

*Ethnic Conflict in World Politics* surveys the historical, geographical, and cultural diversity of ethno-political conflict. Using an analytical model to elucidate four case studies--the Kurds, the Miskitos, the Chinese in Malaysia, and the Turks in Germany--Professors Harff and Gurr give students tools for analyzing conflicts based on the demands of nationalists, indigenous peoples, and immigrant minorities throughout the world. The international community is challenged to respond more constructively to these conflicts than it has in divided Yugoslavia, using the emerging doctrines of peacekeeping and peacemaking that are detailed in the book.

HARFF, Barbara, Associate Professor, and T.R. Gurr, Editors, "Special Issue: Journal of Ethno-Development--18 Articles on Early Warnings of Communal Conflicts and Humanitarian Crises," Detroit: Michigan Ethnic Heritage Studies Center, July 1994, pp. 131.

These are proceedings from a Workshop on early Warnings of Communal Conflicts and Humanitarian Crises which Professor Harff co-chaired on Nov. 5-6 1993. Participants were asked to present papers.

HARFF, Barbara, Associate Professor, and T.R. Gurr, "Conceptual Research, and Policy Issues in Early Warning Research: An Overview," *Journal of Ethno-Development*, Detroit: Michigan Ethnic Heritage Studies Center, July 1994, pp. 3-14.

Early warning models of ethnic conflict explore the possibility of anticipating and responding to crisis situations before they become too violent, or mitigating their effects once underway. Several models exist, utilizing various quantitative and contextual measures. The ideal model(s) should have predictive capability as well as value for making informed judgments about possible sequences of events and outcomes. It should also comprehend the complex nature of ethnicity, and the relations of individual and collective rights. Finally, the model must be integrated into an effective

framework of data-gathering and communication networks.

HARFF, Barbara, Associate Professor, "A Theoretical Model of Genocides and Politicides," *Journal of Ethno-Development*, Detroit: Michigan Ethnic Heritage Studies Center, July 1994, pp. 25-30.

The theoretical model of conditions that lead regimes to use violence against communal groups is expected to be tested by tracing the development and process that led to their onset. The testing of the theory will come through research based on case studies that look at a basic chronology of each of the conflicts, the theoretically-specified conditions of communal conflict and the analysis of accelerators derived from event data from the Global Events Data System (GEDS).

HARFF, Barbara, Associate Professor, "Rescuing Endangered Peoples: Missed Opportunities," *Social Research*, Vol. 61, no. 4 (Spring 1995), pp. 1-18.

The new world order should emphasize collective responsibility and mutual cooperation and should lay the groundwork for an objective basis on which potential ethno-political conflicts and humanitarian crisis can be settled in a manner that would satisfy the majority of international actors. The argument proceeds to address legal, moral and policy issues related to collective intervention; asks if we have learned lessons from the Holocaust; and argues for the necessity of crisis prevention.

LAMB, Karl, Professor, Reasonable Disagreement: "Two U.S. Senators and the Limits of Political Dialogue," currently under review by Garland Publishing, New York, pp. 442.

This book is a parallel political biography of Senators Paul Sarbanes of Maryland and Dick Lugar of Indiana.

MALONE, Eloise, Assistant Professor, Editor, "Readings in Government and Ethics," New York: Custom Publishing Group: American Heritage, 1994.

PURKITT, Helen E., Professor, Editor, "Annual Editions: World Politics 95/6," Sluice Dock, CT: Duskin Publishing Group, 1995.

This book is the sixteenth edition of an annual collection of forty-four articles about recent issues and trends in international affairs. The book is organized into eight sections covering major current issues in each regional subsystem of the world and key policy issue areas related to the global economy, arms

proliferation, and other global issues. Each section begins with an introduction which reviews key trends for the novice reader. This volume is used as a supplemental text in introductory courses in international relations, U.S. foreign policy and national security issues.

PURKITT, Helen E. "Problem Representations and Political Expertise: Evidence from "Think Aloud" Protocols of South African Elites" book chapter to appear in D. Sylvan and J.F. Voss (Eds.), *Problem Representation in International Relationships*, 1995.

This book chapter-length manuscript is an extension of research reported in conference papers in 1992, 1993, and last year in Professor Purkitt's 1994 ISA paper. During AY 1994/5 Prof. Purkitt completed additional process coding of written transcripts from these elite interviews with South Africans, collected during 1992, and reanalyzed all of these interview transcripts using a new free hand cognitive mapping technique which was recommended to her during the 1994 RTG meeting. In December 1994, Prof. Purkitt rewrote this book chapter-length to reference other articles in this forthcoming volume and to address criticisms and suggestions received from peer reviews. Prof. Purkitt revised a (hopefully) final time in February 1995, to accommodate length requirements and some additional requests of the editors.

RACHWALD, Arthur, Professor, "Looking West," in Ilya Prizel and Andrew A. Michta, eds, *Polish Foreign Policy Reconsidered*, New York: St. Martin's Press, 1995, pp. 129-155.

This chapter of a book on Poland's foreign policy explores Polish aspirations to become a member of the Western community of nations. More specifically, Poland is striving for full membership in the European Union and NATO, to achieve a permanent place in the Western World to assure that the country's economic and political systems, cultural and moral values are parallel to the Western part of the European continent. At the same time, the country is becoming an indispensable constituent of the European security system, contributing to the end of the division of Europe, as produced by the Yalta Accord of 1945.

RACHWALD, Arthur, Professor, "The Emergence of a Party System in Russia" paper presented at the 1994 annual meeting of the American Association for the Advancement of Slavic Studies, November 1994, Philadelphia.

The 1994 parliamentary elections in Russia were unique in Russian history. The vote was split primarily

among eight political parties, some of which did not even exist until a few months before. Not only were the parties new, but the electoral mechanisms themselves were novel in that they were designed to encourage party formation. This study focused on the newly formed parties in Russia, and on the emergence of a democratic state structure that incorporates political parties as one important element of the relationship between those governing and those governed.

RAU, Robert L., Professor, "Maritime Security Developments in East and Southeast Asia: Association of Southeast Asian Nations, China and Japan Major Participants" *Ocean Yearbook-11*, Chicago: University of Chicago Press, 1995, pp. 426-441.

This chapter discusses the major security issues prevailing in East and Southeast Asia within the framework of the establishment of Security Regimes (SRs) and Confidence Building Security Measures (CBMs). The security issues include the following questions: joint territorial claims involving Indonesia, Malaysia and Singapore; fisheries disputes throughout the region; unrestricted migration of settlers from country to country; smuggling of contraband, gold, drugs and people; economic zone and archipelagic claims; and the claim of China to the South China sea.

China and Japan as major maritime powers are discussed with emphasis on the Law off the Sea and other legal and security issues covered such as sea lines of communication and the joint claim of China and Japan to the Sengaku Islands. The Association of South East Asian Nations security agenda, as of 1994, is outlined in its maritime aspects.

TOMLINSON, Rodney G., Professor, *Reference Guide to the 49th (1994) United Nations General Assembly Rollcalls*, Washington: United States Department of State, (March 1995).

This is a reference document that analyzes and summarizes voting records of the members of the United Nations for the Forty-Ninth (1994) General Assembly. All rollcalls are studied and catalogued according to agenda, date, location, major and minor subjects, and important related incidents and issues in world affairs. A short descriptive passage is prepared and rollcall votes for each member are appended. A series of cross-reference indexes are prepared to provide quick look by dates, resolution number, agenda number, location, and topical keywords. This document is published for use by members of the U.S. Diplomatic Corps and U.S. missions abroad to facilitate research into positions taken by the nations to which they are accredited.

TOMLINSON, Rodney G., Professor, "Converting Hindsight to Foresight, building Theoretic Models of Genocides and Politicides: Some Ideas from the World Event/Interaction Survey (WEIS)," *Journal of Ethno-Development*, Vol 4, No. 1, (July 1994), pp. 44-55.

Genocide and politicide (G&P) needs improved and more coordinated research in crisis forecasting. Harff's G&P modeling can be made to encompass an array of attribute and interaction indicators, connecting the past with the present. Insight from WEIS may guide the development of accelerators in the Harff model as well as improve the application of event volume measures, variety measures, exponential smoothing, Bayesian probabilities and catastrophe theory.

## Presentations

FRANTZICH, Stephen E., Professor, "High Tech and the Teaching of International Relations." Guest lecturer, Faculty Seminar, U.S. Institute of Peace, Washington, DC, 30 July 1994.

FRANTZICH, Stephen E., Professor, "Basic Elements of American Government," special presentation to Taiwanese Government Officials, George Washington University, Washington, DC, 15 August 1994.

FRANTZICH, Stephen E., Professor, "New Technology and Teaching," Christopher Newport University, Newport News, VA, 25-26 September

1994.

FRANTZICH, Stephen E., Professor, "American Government Basics for the Foreign Service Officer," George Washington University, Washington, DC, 15 October 1994.

FRANTZICH, Stephen E., Professor, "Congress and the New Technology," Virginia Polytechnic Institute, Blacksburg, VA, 20 October 1994.

FRANTZICH, Stephen E., Professor, "Developing a Strategy for Technology in the Classroom," Haverford

College, Philadelphia, PA, 27 January 1995.

FRANTZICH, Stephen E., Professor, "Using C-SPAN in the Classroom," Seminar for College Faculty sponsored by C-SPAN, Washington, DC, 9 January 1995.

FRANTZICH, Stephen E., Professor, "Technology and Teaching American Government," U.S. Air Force Academy, Colorado Springs, CO, 15 March 1995.

FRANTZICH, Stephen E., Professor, "Assessing the Impact of the C-SPAN Revolution," Midwest Political Science Association Annual Convention, Chicago, IL, 7 April 1995.

HARFF, Barbara, Associate Professor, "Deterring Genocides," Annual Convention of the American Sociological Association, Los Angeles, CA, August 1994.

HARFF, Barbara, Associate Professor, "Rescuing Endangered People: Missed Opportunities," Conference on Rescue: The Paradox of Virtue, The New School, New York, NY, 17 November 1994.

HARFF, Barbara, Associate Professor, participant in conference on "Culture and Technology: Towards the Prevention of Genocide, Ethnocide and Politicide," Wayne State University, Detroit, MI, 14-16 January 1995.

HARFF, Barbara, Associate Professor, organizer, chair, and participant of two theme roundtables on Genocide and Politicide I: Cases and Causes and II: Early Warning and Responses, annual meetings of the International Studies Association, Chicago, IL, February 1995.

HARFF, Barbara, Associate Professor, "Human Rights Violations in Internal Conflict: Early Warning Capabilities," Conference on "Strengthening Enforcement of Humanitarian Law, Ethics and National Security," Duke University Law School and the Center for National Security Law, University of Virginia School of Law, Durham, NC, 10-11 March 1995.

MALONE, Eloise F., Assistant Professor, "Quebec: A Distinct Society?" 36th Annual International Studies Association Conference, Chicago, IL, 22-25 February 1995.

MALONE, Eloise F., Assistant Professor, and Alvin Richman (USIA), "Values Underlying the American Public's Support for an Active U.S. Role. A Factor

Analysis." 36th Annual International Studies Association Conference, Chicago, IL, 22-25 February 1995.

PURKITT, Helen E., "The Decision to Abandon the Development of Nuclear Weapons: The Case of South Africa." International Society of Political Psychology Annual Meeting, Santiago de Compostela, Spain, 13 July 1994.

PURKITT, Helen E., "A Defense of the Cognitive Miser." Roundtable on research using cognition using the cognitive miser concept, International Society of Political Psychology Conference, Santiago de Compostela, Spain, 15 July 1994.

PURKITT, Helen E., "The Politics of Denuclearization: the Case of South Africa." Institute for National Studies (INSS), U.S. Air Force Academy, Colorado Springs, CO, 9-10 November 1994.

RACHWALD, Arthur R., Panelist at the American-German workshop on "Political Resistance in Totalitarian Regimes - A Historical Perspective - Lessons to be Learned." Konrad Adenauer Stiftung, Washington, DC, 29 September 1994.

RACHWALD, Arthur R., Panelist at the presentation by Karsten Voigt, Member of the German Bundestag and Spokesman of the Social Democratic Party for Foreign Policy, on "Germany after the Elections: Domestic and Foreign Policy Perspectives." Washington, DC, 27 October 1994.

RACHWALD, Arthur R., Panelist on the panel "The Conduct of American, Foreign and Security Policies," at the 25th Annual Leadership Conference sponsored by the Center for the Study of the Presidency, Baltimore, MD, 15 October 1994.

RACHWALD, Arthur R., Discussant at the seminar on "Poland's Politics and the European Connection," co-sponsored by East European Studies and Polish Advanced Areas Studies of the State Department's Foreign Service Institute at the Woodrow Wilson Center, Princeton, NJ, 27 January 1995.

RACHWALD, Arthur R., Round table moderator at the 37th Air Force Academy Assembly on "U.S. Intervention Policy in the Post Cold War World," Colorado Springs, CO, 14-17 February 1995.

RACHWALD, Arthur R., Panelist at the Washington Chapter meeting of the American Association for the Advancement of Slavic Studies on "Central and Eastern Europe and the Former Soviet Union," Washington,

DC, 21 February 1995.

RACHWALD, Arthur R., Lecture on "Polish-Russian Relations," at the U.S. State Department's Foreign Service Institute, Arlington, VA, 2 March 1995.

RACHWALD, Arthur R., Discussant at the Conference on Polish Studies in the United States, Embassy of the Republic of Poland, Washington, DC, 25-26 March 1995.

RACHWALD, Arthur R., Lecture on "The Security Situation in Eastern Europe," United States Air Force Academy, Colorado Springs, CO, 17 February 1995.

RACHWALD, Arthur R., Four commentaries in the Polish language for the Voice of America, Washington, D.C.: 5 January 1995: "Russian Intervention in Chechnya"; 9 January 1995: "U.S. Policy Toward Russia"; 21 March 1995: "President Clinton's Decision to Visit Moscow for the 50th Anniversary of the End of World War II in Europe"; 5 May 1995: "U.S. Policy on the Expansion of NATO."

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**Division of  
Mathematics and Science**

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# Chemistry

Professor Boyd A. Waite  
Chair

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This past year saw the continued expansion of several exciting research programs within the Chemistry Department, including the molecular modeling/animation studio, the laser laboratory, and the x-ray diffraction laboratory, along with ongoing research efforts in all the traditional sub-disciplines of chemistry. The Chemistry Department faculty and midshipmen chemistry majors are supported by a diverse array of state-of-the-art instrumentation and computational facilities.

The diverse interests of the faculty in both traditional chemical research as well as computational and modeling research continue to attract and involve midshipmen. One Trident Scholar completed a significant kinetics study in the Department's laser laboratory this year, and seven students participated in research courses. A post-doctoral fellow, funded through an Naval Academy Research Council (ONR) grant obtained by one of our faculty, spent the year developing molecular dynamics simulations of friction phenomena, and will continue next year under an extension of the grant. Another faculty member was also awarded an ONR grant, including funding for a post-doctoral fellow, and will be pursuing research in molecular modeling of solvent and substituent effects on the conformational dynamics of biologically active molecules.

The Chemistry Department faculty have continued to pursue collaborative research efforts with Navy laboratories and other government and private institutions, in spite of the difficulties associated with reduced budgets. This year faculty collaborated with projects at the Naval Research Laboratory, the Naval Surface Warfare Center, the National Aeronautics and Space Administration, the Johns Hopkins University, and the University of Missouri. Faculty members were supported by grants obtained from the National Science Foundation, the Research Corporation, and the Office of Naval Research.

Other research interests of the faculty include: organic synthesis of natural products, radio-isotope studies in organic chemistry, modeling studies in developmental biology, preparation of materials for use in methanol fuel cells, hazardous material cataloging and handling, spectroscopic studies of cometary phenomena, kinetics modeling of fiber-optics-based immuno-biosensors, detonation simulations, electrochemical studies of fused salts, and synthesis and characterization of organometallic species, among others. The active involvement of the faculty in research provides strength to the curriculum and helps prepare our chemistry graduates for the technical challenges awaiting them in the fleet.

## Sponsored Research

### Multidisciplinary Studies on Biological Information Systems

Researcher: Assistant Professor John W. Bodnar  
Sponsor: Naval Academy Research Council (ONR)

A fertilized egg contains all the information necessary to determine the identity of an adult animal, and the process of organismal development depends on a series of biochemical events to express that information into structural components of the organism. The information for development is stored in a hierarchy of forms: molecular information in DNA; cellular information in cell nuclei; and organismal information

in tissues throughout the growing organism. Therefore, understanding the biochemistry of organismal development will require an integrated knowledge of biochemical pathways and compartmentalization of information at the molecular, cellular, and organismal levels. Knowledge of biological mechanisms for information access will not only provide a theoretical basis for understanding cancer and other diseases but

also for formulating models to construct biochemical control systems.

The objective of this project is to collate current knowledge on information storage in biological systems to form an integrated theory of organismal development that deals with a growing organism as a biological information system. This research has combined theory, computer simulation, and laboratory experimentation to link together literature from diverse biological disciplines - forming new, integrated theories

to be tested by computer simulation and new experimentation. Specifically, literature compilation and computer simulation have been completed and are being prepared for publication to identify the sequence of steps in regulation of genetic information during the growth of the fruit fly embryo; and literature compilation and lab experiments are in progress to develop an integrated theory on the molecular steps in reorganization of genetic information within the cell nucleus during the cell cycle and viral lytic cycle.

## Temperature Dependent Studies of the Reaction of $W(a^5D_j, a^7S_3)$ with $O_2$

Researcher: Associate Professor Mark L. Campbell

Sponsor: Research Corporation and Naval Academy  
Research Council (ONR)

The gas phase reactivities of  $W(a^5D_j, a^7S_3)$  with  $O_2$  in the temperature range 296 - 575 K are reported. Tungsten atoms were produced by the photodissociation of  $W(CO)_6$  and detected by laser-induced fluorescence. The disappearance rate constant of the  $s^1d^5 a^7S_3$  state is on the order of the gas kinetic rate constant. The removal rate constants for the  $s^2d^4 a^5D_j$  states are J dependent. The  $a^5D_j$  states are not as reactive as the  $s^1d^5 a^7S_3$  state and are found to be temperature dependent. Arrhenius expressions obtained for each state at 20 Torr are:

$$k(a^5D_0) = 2.1 \times 10^{-10} \exp(-12 \text{ kJ/mole/RT}) \text{ cm}^3\text{s}^{-1}$$

$$\begin{aligned} k(a^5D_1) &= 1.9 \times 10^{-10} \exp(-7.1 \text{ kJ/mole/RT}) \text{ cm}^3\text{s}^{-1} \\ k(a^5D_2) &= 5.3 \times 10^{-11} \exp(-9.5 \text{ kJ/mole/RT}) \text{ cm}^3\text{s}^{-1} \\ k(a^5D_3) &= 4.2 \times 10^{-11} \exp(-7.4 \text{ kJ/mole/RT}) \text{ cm}^3\text{s}^{-1} \\ k(a^5D_4) &= 7.3 \times 10^{-11} \exp(-9.2 \text{ kJ/mole/RT}) \text{ cm}^3\text{s}^{-1} \end{aligned}$$

The rate constants for all the states were found to be pressure independent from 10 - 100 Torr. Therefore, adduct formation can be eliminated as an important product. The high reactivity of the  $s^1d^5 a^7S_3$  state towards  $O_2$  may be due to its orbital correlation with the  $WO$  ground molecular orbital configuration. An electron transfer mechanism is not supported by our data.

## Reactions of $W(a^5D_j, a^7S_3)$ with $N_2O$ , $NO$ , $CO_2$ , $SO_2$ and $H_2O$

Researchers: Associate Professor Mark L. Campbell and

Midshipman 1/C James S. S. Harter, USN

Sponsor: Research Corporation

The objective of this work is to investigate the gas phase reactions of several states of tungsten with oxygen-containing oxidants to determine the effect the electron configuration has on reactivity in transition metal atoms. The  $s^2d^4 a^5D_j$  ( $J = 0, 1, 2, 3$  and  $4$ ) and  $s^2d^5 a^7S_3$  states of tungsten reacting with  $N_2O$ ,  $CO_2$ ,  $NO$ ,  $SO_2$ , and  $H_2O$  will be studied as a function of temperature and pressure. By obtaining Arrhenius parameters for these reactions, steric factors and energy barrier effects can be distinguished. Tungsten atoms in the different electronic states are produced by the photodissociation of  $W(CO)_6$  using the 248 nm output of an excimer laser. The tungsten atoms are detected via laser-induced

fluorescence (LIF) utilizing the output of an excimer pumped dye laser. LIF is monitored perpendicular to the counterpropagated laser beams by a photomultiplier tube and captured by a gated boxcar sampling module. The delay time between the photolysis laser pulse and the dye laser probe is varied by a digital delay generator. Rate constants for the  $N_2O$  reaction are nearing completion. The  $a^5D_0$  state reaction with  $N_2O$  is very slow ( $k < 1 \times 10^{-14} \text{ cm}^3/\text{s}$ ). The  $a^5D_j$  ( $J = 2, 3$  and  $4$ ) states are about ten times more reactive with  $N_2O$  than the  $a^5D_1$  state ( $k = 1.4 \times 10^{-13} \text{ cm}^3/\text{s}$ ).



## Quartz Crystal Microbalance Studies of Mercury Deposition

Researcher: Professor Graham T. Cheek

Sponsor: Naval Research Laboratory, Code 6171, Washington, D.C.

In a continuation of a study of mercury/platinum interactions, the quartz crystal microbalance was employed to investigate the characteristics of mercury films deposited onto 200 nm platinum films. As discovered in previous work, mercury deposition onto platinum forms a blocking layer of platinum amalgam which can serve as a base layer for further deposition. Most of the work done in the present study was carried out at the amalgam layer and presumably does not involve interactions with bulk mercury. As a commonly-studied system, the adsorption of halides was investigated in order to evaluate the behavior of the amalgam electrode surface. The results were similar to those seen for platinum amalgam electrodes upon which thin mercury films had been deposited; that is, frequency decreases corresponding to the expected mass increase for monolayer adsorption were observed. These results indicate that the mercury in the amalgam films seems to determine the electrochemical response in the case of halide adsorption.

In other work, attempts were made to deposit mercury films onto silver substrates in 0.10 M  $\text{HClO}_4$ ; however, contact with mercurous ion led immediately to a large frequency increase corresponding to loss of the silver film. This loss was also visually obvious from subsequent inspection. An examination of standard potentials shows a modest driving force for the spontaneous reduction of mercurous ion by metallic

silver, leading to the corrosion of the silver film. Many previous examples of mercury deposition onto silver substrates have been carried out in this medium, and the present work indicates that some mercury has almost certainly been deposited even before intentional potentiostatic reduction of mercurous ion is started. Mercury deposition onto silver in a neutral medium (0.10 M ammonium acetate) was briefly studied, and the stable frequency response indicated that the silver film was stable under these conditions.

Studies were also begun on the oxidation of methanol at platinum in 0.10 M  $\text{HClO}_4$ . At low concentrations (3 mM), methanol oxidation at +0.5 V vs Ag/AgCl results in a frequency decrease of only 5 Hz, undergoing a somewhat larger increase on the return sweep as the oxide layer is reduced. When the concentration is increased to 30 mM, the frequency decreases by 25 Hz during oxidation, returning to the initial value during oxide reduction. The frequency response at potentials more positive than +0.7 V is more complex and involves another oxidation process at +0.9 V. These observations suggest the possibility that methanol oxidation results in the formation of adsorbed products which desorb during oxide reduction on the return potential sweep. Coupled with spectroscopic investigations, this work is expected to clarify the nature of surface processes accompanying methanol oxidation in fuel cells.

## Synthesis and Modeling of Organodiphosphonates

Researcher: Associate Professor Debra K. Dillner

Sponsor: Naval Academy Research Council (ONR)

This project's goal is the production of a series of organodiphosphonates which will be used in the preparation of pillared layered metal phosphonates. The pillared layered compounds are of interest as potential materials for ion conducting separators for an elevated temperature methanol fuel cell. An ideal separator needs to be an efficient proton conductor while inhibiting anion diffusion. Alpha-layered zirconium phosphates are known to be proton conducting materials whose conductance depends on the distance between the zirconium layers. The properties of these compounds may be adjustable by rationally varying the interlayer distance. This project will investigate that possibility by introduction of diphosphonates which will bond to zirconium atoms in two different layers. In addition, placement of an electronegative group on the organodiphosphonate

moiety should lead to enhanced proton conductance due to electrostatic interaction between the protons and an appropriate group on the organodiphosphonates.

To allow for systematic variation of the interlayer distances, a variety of organodiphosphonates must first be prepared. The diphosphonates will vary by length of the carbon chain connecting the two phosphonate functional groups. Initial plans call for the synthesis of three, five, and seven carbon separating chains. Distance between metal layers should become greater as the chain length increases. A flexible synthesis of these diphosphonates is being developed which will allow for modification of the chain length to any size found to be optimal for conduction.

The initial phase of the investigation was development of methodology for preparation of the diphosphonates containing a hydroxyl group on the

central atom of the carbon chain. This was accomplished using a Michaelis-Arbuzov reaction between triethyl phosphite and 1,3-dichloro-2-propanol. This reaction gave the desired diphosphonate in excellent yield. No protection of the hydroxyl group was necessary although a parallel strategy using a silyl protected alcohol was also developed. With this material in hand, studies can be carried out on incorporation of this compound into a layered zirconium material. A procedure for hydrolysis of the phosphonate ester to the free phosphonic acids was also investigated. Having both compounds available will

give flexibility in construction of the layered compounds. To utilize the Michaelis-Arbuzov procedure for the longer chain compounds, the corresponding  $\alpha,\omega$ -dihalides must be prepared. A synthesis of the five carbon analog is being carried out and several advanced intermediates have been prepared. A method for preparation of the seven carbon analog is also being investigated. Synthesis of the diphosphonates will be completed as soon as conditions for preparation of the layered zirconium materials have been perfected.

### **Molecular Dynamics Study of Reaction Zone Length in Condensed-Phase Detonation**

Researcher: Professor Mark Elert

Sponsor: Naval Research Laboratory, Code 6170, Washington, D.C.

When a detonation propagates through a solid, exothermic reactions behind the shock front provide the energy to sustain the front. To investigate the range over which these chemical reactions occur, and over what distance the energy thus generated can be transmitted to the shock front, molecular dynamics simulations were performed using a previously introduced two-dimensional diatomic model system.

Atoms were eliminated from the simulation when they reached a fixed distance behind the shock front, and the results were compared to a full simulation in which all atoms were retained. Atom elimination at a cutoff distance as small as four nanometers behind the shock front was found to cause minimal change to shock front properties including peak density, peak temperature, and shock velocity.

### **Laboratory Studies of Ices Deposited on Amorphous Silicate Grains**

Researcher: Associate Professor Robert F. Ferrante

Sponsor: National Aeronautics and Space Administration (NASA),  
Goddard Space Flight Center

Recent work has indicated that the use of silicate grain analogs as a substrate for simple ices of astrophysical interest ( $H_2O$ ,  $CH_3OH$ , etc.) may have an effect on the crystallization behavior of those ices in laboratory studies. The ices are observed to form in the crystalline phase, even during deposition at temperatures near 10 K; in contrast, similar studies performed in the absence of the silicate lead only to amorphous ices on low temperature deposition. Comets and other interstellar objects are believed to have formed by the accretion of silicate grains upon which volatile molecules have condensed as ices; the particles may have undergone various types of processing both before and after accretion. Laboratory studies of the type described above have been used to model such condensation processes, and their results employed in the interpretation of the thermal history of the natural systems. Such models have always assumed the formation of amorphous ice at low temperatures; the recent results suggest a re-evaluation of that assumption. The

work proposed here is designed to expand the range of observations and conditions affected by the presence of the silicate surface, and to explore in more detail the mechanistic implications of these and earlier results. The goal is to provide a better understanding of the significance of these observations towards interpretation of astrophysical data.

This work continues in an attempt to examine the generality of the effect, and to explore the cause. Work on other treatments of the silicate smokes (oxidation, reduction, re-use), and examination of the effects of (or upon) polymerization, proton irradiation, ultraviolet irradiation, inclusion of other incompletely oxidized metal smokes, etc. are ongoing. Additional work on probing the ice-smoke interaction through the use of deuterated dangling-bond markers and other techniques are being introduced.

This research is being conducted at NASA's Goddard Space Flight Center in Greenbelt, Maryland.

## Hazardous Material Minimization Program

Researcher: Associate Professor Frank J. Gomba  
Sponsor: Carderock Division, Naval Surface Warfare Center,  
Code 632, Annapolis, Maryland

A program to minimize the number of hazardous materials used aboard United States Navy ships is underway at the Carderock Division, Naval Surface Warfare Center, Annapolis. A significant portion of this program has been the identification of hazardous materials used in shipboard work centers and the establishment of a comprehensive database management system of shipboard hazardous material information.

The major accomplishment to date has been the consolidation of hazardous material and shipboard hazardous material application/use from various information resources into a comprehensive relational multi-user database management system. An additional

database management system (PC based) has also been developed specifically to assist us to qualitatively evaluate the hazardous materials to determine the least hazardous, technically capable materials to accomplish the required task. The hazardous materials have been grouped into primary- and sub-classes according to use and material type.

This initial report focuses on recommendations to minimize Class I materials: Cleaning Compounds and Solvents (CC/S). Recommendations for minimization consider material substitution, elimination, consolidation or specification, revision and development, and if required, process changes.

## The Atomic-Scale Friction and Wear of Diamond and Related Materials

Researchers: Dr. Martin D. Perry, Jr., Postdoctoral Associate,  
and Assistant Professor Judith A. Harrison  
Sponsor: The Office of Naval Research

Friction and the related phenomenon of wear are two of the more costly problems facing industry today. Understanding and ultimately controlling friction and wear has long been recognized as being central to many areas of technology. For instance, combustion engines break down usually because of friction induced wear and cutting tools become dull. Despite the obvious importance of friction and the induced wear, much of the atomic-scale dynamics responsible for these phenomena remain elusive. If the atomic-scale origins of friction and wear were understood, this might ultimately lead to the design of materials with specific friction and wear properties.

Molecular dynamics simulations have been used to investigate the atomic-scale origins of friction and wear in hydrocarbon systems. Previously, the atomic-scale friction which resulted when two diamond (111) surfaces are placed in contact was examined. The friction was examined as a function of load, sliding direction, and chemisorbed groups on the diamond surface. It was recently shown that, at large loads, the wear of diamond surfaces can be initiated by the

shearing of hydrogen atoms from the chemisorbed hydrocarbon groups. Once the initiation step took place, a number of tribochemical reactions (reactions initiated by sliding) were possible. Using molecular dynamics simulations, it was possible to catalog these reactions and their atomic-scale mechanisms. It was also shown that these reactions and their products were consistent with inferences drawn from macroscopic friction experiments on diamond.

When diamond films are grown using chemical vapor deposition the predominate facets are the (111) and the (100). For this reason, a detailed knowledge of the frictional behavior of diamond must include knowledge of the frictional properties diamond (100). With this in mind, the friction between two diamond (100) surfaces in contact was examined. The friction as a function of applied load and sliding direction was investigated and compared to earlier data from the diamond (111) system. It was shown that the frictional behavior as a function of load on the diamond (100) surface was nearly identical to the behavior on the (111) surface.

## Investigation of the Electronic and Phonon Contributions to Friction

Researchers: Assistant Professor Judith A. Harrison  
Sponsor: National Science Foundation

Simply defined, friction is the dissipation of energy. On the macroscopic scale, energy can be lost by the movement of dislocations or by plastic deformation of the material. On the atomic-scale, where "wearless" friction is possible, other energy dissipation mechanisms are important. Both atomic-scale experiments and theoretical models have shown that one way energy can be dissipated on the atomic-scale is via phonons. More recently, it has been suggested that friction, or energy dissipation, might have an electronic component. That is, the movement of electrons, in addition to the movement of phonons, might contribute significantly to observed friction coefficients.

Recent Quartz Crystal Microbalance (QCM) experiments have examined the frictional properties of ethane ( $C_2H_6$ ) and ethene ( $C_2H_4$ ) monolayers deposited on silver (Ag) substrates. Theory predicts that the friction coefficients for the ethene monolayer system, where electronic effects are possible, should be higher

than for the ethane monolayer system. Indeed, the QCM experiments consistently measured larger friction coefficients for the ethene monolayer system. However, this experimental result does not prove that electronic effects are the cause of the higher friction coefficients. Other factors, such as the geometry of the film, might be the cause of the higher friction coefficients.

Molecular dynamics simulations will be used to examine the effects of the geometry of the ethane versus ethene films on friction. The researchers at Johns Hopkins University have begun to construct a molecular dynamics code that can model the silver surfaces. The researchers at the United States Naval Academy have begun constructing code which can model the ethane and ethene monolayers. Once both projects are completed, the computer codes will be joined and the friction of the monolayers on the silver surfaces can be examined.

## Electrosynthesis of Partially-Oxidized Metal Bis(Dioxime)Salts of the Nickel Group

Researcher: Assistant Professor William B. Heuer  
Sponsor: Naval Academy Research Council (ONR)

Electrochemical crystallization of metal bis(dioxime) complexes is being explored as an avenue to novel partially-oxidized one-dimensional metal chain compounds. It is anticipated that such compounds will be more amenable to spectroscopic studies of the bonding interactions within the one-dimensional metal atom chains than are the corresponding halogen-doped materials. Efforts thus far have focused on electrochemical oxidation of complexes of diphenylglyoxime (dpg) with nickel-group metals in the presence of linear anions such as  $CuBr_2^-$  and  $Au(CN)_2^-$ . Owing to the generally poor solubility characteristics of the  $M(dpg)_2$  complexes, electrocrystallization runs were

conducted in a thermoregulated high temperature bath. Initial oxidations of  $Ni(dpg)_2$  in 1,2-dichlorobenzene using  $[(n-Bu)_4N]CuBr_2$  as the supporting electrolyte were unsuccessful, evidently due to the susceptibility of the  $CuBr_2^-$  ion to oxidation. Preliminary results indicate that the  $Au(CN)_2^-$  ion is much less susceptible to oxidation, and thus may prove to be a more appropriate choice of electrolyte for these oxidations. Since  $Pt(dpg)_2$  should likewise be more easily oxidized than its nickel analogue, future experiments will focus on the electrochemical oxidation of  $Pt(dpg)_2$  using  $[(n-Bu)_4N]Au(CN)_2$  as the supporting electrolyte in a variety of solvents.

## Radiotracer Study of the Delta Opiate Receptor

Researcher: Assistant Professor Christopher M. Kinter  
Sponsor: Naval Academy Research Council (ONR)

The use of radiotracers for the study of biochemical processes in animals relies heavily on the isotopes C-14 and H-3. Only with the advent of the use of the short-lived, positron emitting isotopes (C-11, N-13, O-15, F-

18) and the radioisotopes of iodine (I-123, I-125) have the means become available for extending these studies directly to human subjects. Two imaging modalities using the short-lived isotopes, Positron Emission

Tomography (PET) and Single Photon Emission Computed Tomography (SPECT), provide the means for noninvasive measurement of neurotransmitter receptor densities and metabolic change in human subjects. In this research neuroreceptor ligands are designed, synthesized, fully characterized, and radiolabeled with either tritium, the positron-emitting isotopes (C-11, F-18), or the radioisotopes of iodine (I-123, I-125). This work is done in collaboration with researchers in the Division of Radiation Health Sciences at The Johns Hopkins University Medical Institute.

This research program has been designed so that students may make significant contributions to the research effort. Within the project are opportunities for organic methodology development, target oriented synthesis, and the study of the incorporation of radioisotopes into pharmacologically important molecules. In so doing, additional experience will be gained by the student in all phases of synthetic organic chemistry, in addition to acquiring knowledge of radiochemical synthesis and the methods involved in drug development.

## Reaction Kinetics of Mo with SO<sub>2</sub>, CO<sub>2</sub>, NO, and N<sub>2</sub>O

Researcher: Assistant Professor Roy E. McClean  
Sponsor: Naval Academy Research Council (ONR)

The gas phase reaction kinetics of Mo(*a*<sup>7</sup>S<sub>3</sub>, *a*<sup>5</sup>S<sub>2</sub>, *a*<sup>5</sup>D<sub>1</sub>) with SO<sub>2</sub>, CO<sub>2</sub>, NO, and N<sub>2</sub>O were investigated as a function of temperature (298 - 620 K) and total pressure (10 - 600 Torr) in helium and argon buffer gas. These studies were conducted to determine possible oxidation mechanisms of molybdenum atoms in low lying electronic states.

A laser photolysis/laser-induced fluorescence technique was used. Mo(CO)<sub>6</sub> (or MoCl<sub>4</sub>) was photodissociated at 248 nm by the output of an excimer laser, and the formed molybdenum atoms were monitored by laser-induced fluorescence. All states of Mo reacting with SO<sub>2</sub> were found to proceed at or near the gas kinetic limit. Reaction of ground state Mo

(*a*<sup>7</sup>S<sub>3</sub>) with CO and N<sub>2</sub>O were inefficient in the temperature and pressure ranges investigated; observed rate constants are less than 1 × 10<sup>-10</sup> cm<sup>3</sup> s<sup>-1</sup>. However, reaction of the excited states with CO<sub>2</sub> and N<sub>2</sub>O were observed and were found to exhibit a positive temperature dependence. A pressure dependence was not observed. The reaction of Mo(*a*<sup>7</sup>S<sub>3</sub>) with NO exhibited a strong pressure dependence, indicating adduct formation. This observation was expected because MoO production from said reactants are endothermic. A pressure dependence was not observed for the excited states although a positive temperature dependence was observed.

## Reaction Kinetics of Mo with Sulfur-Containing Compounds

Researcher: Assistant Professor Roy E. McClean  
Sponsor: Naval Academy Research Council (ONR)

An investigation into the reactivity of Mo atoms toward the sulfur-containing compounds H<sub>2</sub>S, OCS, CS<sub>2</sub>, CH<sub>3</sub>SH, and CH<sub>3</sub>CH<sub>2</sub>SH is in progress. Only the reaction kinetics of Mo with H<sub>2</sub>S at room temperature have been investigated thus far. Mo(*a*<sup>7</sup>S<sub>3</sub>) reacts with a

rate constant of 2.0 × 10<sup>-13</sup> cm<sup>3</sup> s<sup>-1</sup>, and the excited states react with rate constants on the order of 1 × 10<sup>-10</sup> cm<sup>3</sup> s<sup>-1</sup>. This work will continue throughout the next academic year.

## Conformational Analysis of Biologically Active Compounds

Researcher: Assistant Professor Joseph J. Urban  
Sponsor: Naval Academy Research Council (ONR)

This project focuses on the application of molecular modeling techniques to problems in organic and bioorganic chemistry. Molecular modeling is a general term for research that employs a variety of computational techniques such as molecular mechanics, quantum mechanics, molecular simulations, and graphics. There are two major goals of this type of

research. The first is to use the computer modeling techniques to aid in the interpretation of experimental results. The other is to use the modeling techniques to make predictions about novel systems, or systems that are difficult or impossible to study experimentally.

The research centers on two major themes. The first is an examination of the intramolecular interactions

and substituent effects that determine the intrinsic conformational preferences of biologically active compounds. The second area involves studying the intermolecular interactions between bioactive compounds and the surrounding solvent or receptor environment. In particular, work is currently underway on compounds with central nervous system activity, such as neurotransmitters and neurotoxins, which are

structurally related to acetylcholine and dopamine. The effect of fluorine substitution on the solvation, conformational and electronic properties of the amino acid tyrosine is also being investigated. The motivation for this work is to gain a better understanding of the aromatic ring cleavage mechanism of the enzyme tyrosine phenol-lyase.

## Computational Investigations of Conformational Effects Involving Aromatic Rings

Researcher: Assistant Professor Joseph J. Urban  
Sponsor: Office of Naval Research

Aromatic rings are present in a variety of natural and synthetic materials ranging from proteins to polymeric resins. The local conformational ramifications of aromatics rings have traditionally been understood in terms of the steric repulsive requirements of aryl groups. However, many interesting attractive electronic interactions involving aromatic rings have been reported in the literature. These include aryl---gamma-heteroatom interactions, C-H---pi interactions between aryl groups and neighboring alkyl groups, and pi-stacking interactions between adjacent aryl groups. This research involves a systematic

investigation of these interactions using high-level ab initio calculations. The purpose of this work is to elucidate the nature and magnitude of these interactions by examining the substituent effects computationally. Also, the ab initio data acquired in this work will be extremely useful in evaluating molecular mechanics force fields in their description of these subtle electronic effects. This is of great interest because classical potentials are crucial in modeling the properties of macromolecules through molecular mechanics and molecular dynamics techniques.

## Reaction Kinetics of Mo( $a^7S_3$ , $a^5D_4$ , $a^5S_2$ ) with CO<sub>2</sub>, N<sub>2</sub>O, SO<sub>2</sub> and N<sub>2</sub>O

Researcher: Midshipman I/C Robert H. Goodwin, USN  
Adviser: Associate Professor Mark L. Campbell  
Sponsor: Trident Scholar Program

The gas phase reactivities of Mo( $a^7S_3$ ,  $a^5D_4$ ,  $a^5S_2$ ) with CO<sub>2</sub>, N<sub>2</sub>O, SO<sub>2</sub> and N<sub>2</sub>O were measured under pseudo first-order conditions ([Mo] << [oxidant]). The reactivities were measured over a temperature range of 297-600 K and a pressure range of 20-300 Torr using an argon buffer. Mo atoms were produced by the photodissociation of Mo(CO)<sub>6</sub> or MoCl<sub>4</sub> and detected by laser-induced fluorescence. The concentration of Mo during its reaction with the oxidants was measured as a function of laser delay. This temporal behavior of Mo yields first order decay rate constants from which second order rate constants are determined.

Biexponential behavior was noted in N<sub>2</sub>O and CO<sub>2</sub> reacting with Mo( $a^5S_2$ ). It was found from the rate constants for the reactions of N<sub>2</sub>O and CO<sub>2</sub> with the  $a^5S_3$  and  $a^5D_4$  states of Mo, that the excited state with the  $s^1d^5$  configuration reacts faster than the states with the  $s^2d^4$  configuration. This observation is attributed to the correlation of the  $s^1d^5$  configuration to the ground state of MoO. N<sub>2</sub>O and CO<sub>2</sub> reacted slowly with Mo in the ground  $a^7S_3$  state due to the reaction being a spin forbidden process. NO reacting with the ground state showed a pressure dependent behavior. SO<sub>2</sub> reacted near the gas kinetic rate in all states studied.

## Independent Research

### Digital Simulation of Organismal Growth

Researcher: Assistant Professor John W. Bodnar

In accordance with the present research, the processes involved in the growth and development of a biological organism are approximated by means of a digital switching network based on various factors, involving chromatin structures of genes and biochemical regulatory molecules switched under control of threshold mechanisms pursuant to Boolean logic rules. Based on the foregoing digital switching network, a series of digital logic statements are obtained for

integration into a program from which the growth and development processes may be simulated. Such logic statements form the basis of the simulation program describing molecular and cellular processes, cell cycle linkages between recurring processes and between inputs and outputs of cell cycles in terms of regulator concentration, patterns of digital gradients and program changes under Boolean logic rules.

### **Electrochemical Studies of Acetonitrile/Aluminum Chloride Solvent System**

Researcher: Professor Graham T. Cheek

In continuing work on this project, the characteristics of this solvent system are being compared to those of certain room-temperature molten salt systems. As part of this work, the potential limits for voltammetry carried out in acetonitrile(AN)/aluminum chloride mixtures were investigated in considerable detail. A relatively simple solvent drying procedure has been developed during this investigation. The cathodic background process occurs at approximately -3.5 V vs. ferrocene/ferrocenium couple at both vitreous carbon and platinum and may involve reduction of complexed aluminum ion in the solvent. This is a point of considerable interest because aluminum reduction occurs much more easily in the acidic room-temperature

molten salt systems. The aluminum species involved in the present system  $[Al(AN)_5Cl^{2+}]$  is evidently much more difficult to reduce than  $Al_2Cl_7^-$  found in the molten salt systems. It seems likely that the kinetics for reduction of the aluminum species in the acetonitrile-based system is slow, as can be inferred from the broad reduction processes seen even when an aluminum wire is used as the electrode. In any event, this observation indicates that the acetonitrile/aluminum chloride system has a much wider potential range under acidic conditions than do most room-temperature chloroaluminate molten salt systems. Further work is expected to establish procedures for changing the Lewis acidity of the solvent system by chloride addition.

### **Pyrroles from Reaction of 1,2-Bis(trifluoromethyl)-1,2-dibromoethylene and Copper(I) Cyanide in N,N-Dimethylformamide**

Researcher: Associate Professor Jeffrey P. Fitzgerald

In an effort to develop an improved synthesis of 1,2-bis(trifluoromethyl)-1,2-dicyanoethylene, the reactions of 1,2-bis(trifluoromethyl)-1,2-dibromoethylene with copper(I) cyanide were investigated. With N,N-dimethylformamide (DMF) as the solvent, production of 3,4-bis(trifluoromethyl)-2-cyano-1-methylpyrrole and 3,4-bis(trifluoromethyl)-2,5-dicyano-1-methylpyrrole was observed in moderate yields. The major product depended on the initial ratio of reactants, the monocyano product being favored at low CuCN to

dibromoethylene ratios. The products were identified by IR, coupled and decoupled  $^1H$ ,  $^{13}C$  and  $^{19}F$  NMR spectroscopy, mass spectrometry and, in the case of the monocyano product, a single crystal structure determination. Reactions run with  $^{13}C$ -labelled CuCN indicate that the solvent, DMF, is being incorporated into the pyrrole ring, a heretofore unprecedented reaction. The scope and generality of this reaction as well as its mechanism is the subject of ongoing research.

### **Synthesis and Characterization of Intermediate-Spin Iron(III) Octaethyltetraazaporphyrin Complexes with Weakly Coordinating Anions**

Researcher: Associate Professor Jeffrey P. Fitzgerald

The metathesis reaction of  $AgZ$  ( $Z = ClO_4^-$ ,  $PF_6^-$ ,  $SbF_6^-$  or  $CF_3CO_2^-$ ) with iron(III) octaethyltetraazaporphyrin

chloride,  $Fe(OETAP)Cl$ , in tetrahydrofuran or toluene gives the  $Fe(OETAP)Z$  derivatives in approximately

seventy percent yield. The complexes are air stable solids but decompose in solution to  $[\text{Fe}(\text{OETAP})]_2\text{O}$  ( $Z = \text{ClO}_4^-$  or  $\text{CF}_3\text{CO}_2^-$ ) or  $\text{Fe}(\text{OETAP})\text{F}$  ( $Z = \text{PF}_6^-$  or  $\text{SbF}_6^-$ ). The compounds have been characterized by variable temperature magnetic susceptibility measurements and Mössbauer, UV-visible, IR, and ESR spectroscopy. In addition,  $\text{Fe}(\text{OETAP})\text{ClO}_4$  has been

structurally characterized by single crystal X-ray diffraction. All of the complexes are intermediate-spin ( $S = 3/2$ ) based on their magnetic properties and Mössbauer and ESR spectra. This behavior is in sharp contrast to ferric porphyrins which show a strong spin state dependence on the strength of the anionic axial ligand.

## Coordination and Solid State Chemistry of Metal Dithiocroconate Complexes and Derivatives

Researcher: Assistant Professor William B. Heuer

Preparation and Characterization of a series of bis- and tris-dithiocroconate (dtroc=cyclopentenetrione-1,2-dithiolate) complexes have been completed. Reaction of  $[\text{M}(\text{dtroc})_x]^{z-}$  complexes with malononitrile in DMF has been found to result in clean substitution of the oxygen of the ketone group in the 4-position of the coordinated ligand with a dicyanomethylene (dcm) group yielding the corresponding  $[\text{M}(\text{dcm}(\text{dtroc})_x)]^{z-}$  complexes. This substitution has a pronounced effect on both the UV-VIS absorptions and the electrochemical properties of the complexes. This confirms both the charge-transfer (or ligand-based) character of the transitions responsible for the intense visible absorptions and the ligand-based nature of the

reversible oxidation/reduction chemistry. ESR and static susceptibility measurements of the complexes indicate that the environment of the central metal ion is not perturbed significantly by the ligand modification. The single crystal x-ray structure of  $[(n\text{-Bu})_4\text{N}]_2[\text{Pd}(\text{dcm}(\text{dtroc})_2)] \cdot \text{I}_2$  has been obtained in collaboration with Professor Pearson of the United States Naval Academy Chemistry Department. The planar palladium complex anions are linked together by  $\text{I}_2$  molecules which interact through van der Waals forces with the sulfur atoms of adjacent anions in the structure. Efforts to incorporate complex anions from these series into conductive and/or magnetic solids are also ongoing.

## Synthesis and Characterization of Ferrocenyl Disulfide Polymers

Researcher: Assistant Professor William B. Heuer

A possible photochemical route to deposition of ferrocenyl disulfide polymers is being investigated. During the past year, gram quantities of 1,2,3-trithia-

[3]-ferrocenophane, a key starting material for the synthesis of the proposed photochemically reactive polymer precursor, have been prepared.

## Photochemically Induced Transformations of Transition Metal Complexes

Researcher: Associate Professor Joyce E. Shade and Assistant Professor Wayne H. Pearson

Photolysis of the dinuclear complex  $[(\eta^5\text{-C}_5\text{H}_5)\text{Fe}(\text{CO})_2]_2$  in  $\text{CHCl}_3$  results in the formation of  $(\eta^5\text{-C}_5\text{H}_5)\text{Fe}(\text{CO})_2\text{Cl}$  through intermediate 17-electron radicals of the form  $(\eta^5\text{-C}_5\text{H}_5)\text{Fe}(\text{CO})_2$ . The photolyses of the related diphosphine-bridged compounds  $[(\eta^5\text{-C}_5\text{H}_5)\text{Fe}(\text{CO})]_2\text{-}\mu\text{-DPPX}$  (where DPPX = DPPM, DPPE and DPPP and, therefore, are  $(\text{Ph}_2\text{P})_2\text{CH}_2$ ,  $(\text{Ph}_2\text{P})_2\text{C}_2\text{H}_4$  and  $(\text{Ph}_2\text{P})_2\text{C}_3\text{H}_6$  respectively) have been conducted in chloroform using ultraviolet light. In contrast to the simple iron carbonyl dimer, the phosphine bridged diiron compounds yield a golden dimeric product which contains the phosphine ligand

intact as a bimetallic bridge. In the case of the DPPM and DPPE systems, incorporation of chloride ligands from the solvent into the isolated products is not observed. However, formation of a formyl substituent on one of the previously symmetrical cyclopentadienyl rings has been confirmed spectroscopically through infrared analysis, multinuclear NMR and X-ray diffraction studies. The proposed mechanism for the formation of such a complex appears to involve a radical intermediate and follows a modified Reimer-Tiemann reaction. Such a pathway is believed to be unprecedented in the photochemistry of bimetallic



complexes. In the case of the DPPP complex, the golden product that is isolated also contains the phosphine substituent as a bimetallic bridge. The bidentate ligand, however, appears to be too long to allow a metal-metal bond and the resulting product contains symmetrical cyclopentadienyl rings on each iron center along with the chloride ligand and a carbonyl group.

In the synthesis and purification of the analogous

ruthenium dimer,  $[(\eta^5\text{-C}_5\text{H}_5)\text{Ru}(\text{CO})]_2\text{-}\mu\text{-DPPM}$  and the attempted synthesis of the DPPE compound,  $[(\eta^5\text{-C}_5\text{H}_5)\text{Ru}(\text{CO})]_2\text{-}\mu\text{-DPPE}$ , two ruthenium monomers of the form  $(\eta^5\text{-C}_5\text{H}_5)\text{Ru}(\text{Cl})\text{DPPX}$  resulted.  $^1\text{H}$ ,  $^{31}\text{P}$  and  $^{13}\text{C}$  Nuclear Magnetic Resonance spectra have been obtained for both monomers. In addition, the structures of the two compounds have been verified using X-ray crystallography. Further synthetic studies are underway to produce the desired dimers in high yield.

## Photochemical Study of Cyano-Isocyanide-Phosphine Complexes of Iron and Ruthenium

Researcher: Associate Professor Joyce E. Shade

The chemistry of carbonyl-cyano-phosphine complexes of iron has been studied extensively for the last ten years. In general, reflux or photolytic reaction conditions have been employed to initiate the loss of a carbonyl (CO) group from cyclopentadienyl-iron-carbonyl starting materials with a subsequent inclusion of a phosphine or phosphite ligand on the metal center. The resulting complexes obtained in these studies, however, all contain at least one carbonyl group. The purpose of this research was to prepare a series of anionic, neutral and cationic cyano, mono- and bisisocyanide complexes for reaction with phosphine or phosphite groups under photolytic conditions.

Photolysis of the monoisocyanide complex,  $(\eta^5\text{-C}_5\text{H}_5)\text{Fe}(\text{CO})(\text{CN})(\text{CNCH}_3)$ , in the presence of a slight excess of triphenylphosphine at room temperature gave the desired product  $[(\eta^5\text{-C}_5\text{H}_5)\text{Fe}(\text{CN})(\text{CNCH}_3)(\text{PPh}_3)]$  with loss of one equivalent of carbon monoxide. Two additional products have been obtained, however:  $(\eta^5\text{-C}_5\text{H}_5)\text{Fe}(\text{CNCH}_3)_2(\text{CN})$  and  $(\eta^5\text{-C}_5\text{H}_5)\text{Fe}(\text{CN})(\text{PPh}_3)_2$ . Similar results were obtained with a variety of phosphine, phosphite, arsine and

antimony ligands. Several of the reaction products have been isolated from the fairly clean reaction mixtures and a variety of spectral data have been obtained to verify their identity. Further purification and characterization of these compounds are continuing. In addition, trends of reaction product yields with bulk and basicity of ligand are being studied. Effect of ligand identity (both on the metal prior to photolysis and as an incoming group), wavelength of the photolysis lamp, and temperature of the reaction mixture are being studied as they affect the reaction products obtained. Anionic and cationic starting materials are being investigated under a variety of reaction conditions in order to analyze the system for any trend which might develop as a function of complex charge. A collaborative effort was established with Professor Antony Rest at The University in Southampton in an effort to conclusively identify the reaction intermediate(s). The results of this work have been very promising and the identity of the reaction intermediate has been postulated, as a result of low-temperature matrix isolation studies conducted by Professor Rest. Work on the project is continuing with a shift in focus to the analogous ruthenium species.

## Pentaphenylcyclopentadienyl Derivatives of Molybdenum and Tungsten Carbonyls

Researcher: Associate Professor Joyce E. Shade

Previous work examined the synthesis and chemistry of substituted cyclopentadienyl metal compounds in which simple functional substituents were introduced at one or two of the carbons of the 5-membered cyclopentadienyl ring. The focus of this research was the chemistry of molybdenum and tungsten carbonyl compounds containing sterically encumbered pentaphenylcyclopentadienyl rings. Research by Tyler, et al., had demonstrated that  $[(\text{Ph}_5\text{C}_5)\text{Mo}(\text{CO})_3]_2$  formed an equilibrium with two  $(\text{Ph}_5\text{C}_5)\text{Mo}(\text{CO})_3$  radical

species.  $[(\text{Ph}_5\text{C}_5)\text{M}(\text{CO})_3]_2$ , where  $\text{M} = \text{Mo}$  or  $\text{W}$ , was prepared following the low-temperature anion oxidation route developed by Tyler. Photolysis of the metal-metal bonded dimers in the presence of a chlorocarbon gave  $(\text{Ph}_5\text{C}_5)\text{M}(\text{CO})\text{Cl}$  derivatives, as expected by radical reactions. Both the molybdenum and tungsten hexacarbonyl dimers demonstrated thermal and photochemical carbonyl loss to give tetracarbonyl, triply bonded derivatives. Reaction of the  $(\text{Ph}_5\text{C}_5)\text{M}(\text{CO})_3$  anions with  $\text{R-Cl}$ , where  $\text{R} = \text{CH}_3$ ,

$\text{CH}_2\text{Ph}$ , and  $\text{CH}=\text{CH}=\text{CH}$ , yield the expected  $(\text{Ph}_5\text{C}_5)\text{M}(\text{CO})_3\text{R}$  derivatives. The use of allyl bromide, however, was found to yield the unexpected product of  $(\text{Ph}_5\text{C}_5)\text{M}(\text{CO})_3\text{Br}$ . Photolysis of  $(\text{Ph}_5\text{C}_5)\text{M}(\text{CO})_3\text{-CH}_2\text{-CH=CH}_2$  gives the tri-hapto-allyl derivative in good yield. Reaction of the metal

$(\text{Ph}_5\text{C}_5)\text{M}(\text{CO})$  anions with  $4 \text{ HBF}$  gave the corresponding hydridic species. Although all the compounds synthesized in this study have been found to be remarkably stable in air, there is no other obvious effect on the chemistry resulting from the protective umbrella of the  $\text{Ph}_5\text{C}_5$  ligand.

## Research Course Projects

### Computer Identification of DNA Regulatory Sites "Anonymous" Eukaryotic DNA Sequences

Researcher: Midshipman I/C Scott Miller, USN

Adviser: Assistant Professor John W. Bodnar

A fertilized egg contains all the information necessary to determine the identity of an adult animal, and the process of organismal development depends on a series of biochemical events to express that information into structural components of the organism. The information for development is stored in a hierarchy of forms: molecular information in DNA; cellular information in cell nuclei; and organismal information in tissues throughout the growing organism. Therefore, understanding the biochemistry of organismal development will require an integrated knowledge of biochemical pathways and compartmentalization of information at the molecular, cellular, and organismal levels. Knowledge of biological mechanisms for information access will not only provide a theoretical basis for understanding cancer and other diseases but also for formulating models to construct biochemical control systems. This research has combined theory, computer simulation, and laboratory experimentation to link together literature from diverse biological disciplines - forming new, integrated theories to be tested by computer simulation and new experimentation.

From these theories it has become apparent that the sequence organization of the DNA genome of eukaryotic organisms has a syntax much like the programming language of a computer that allows recall of genetic information during organismal development. Knowing this syntax one could use cryptographic techniques to find and identify important DNA regulatory sequence on the basis of the their frequency and distribution within a given genome. Therefore, a computer program was written that allows the user to "scan" known DNA sequences to test known and predicted regulatory sequences against their recurrence frequency and distribution within the genome. The output of this program is in the form of a color-coded histogram with different colors representing the density of up to eight specific DNA sequence elements within a given DNA locus. The program is now being used to study and compare the distribution of known DNA regulatory elements in well studied viral genomes to develop methods for identifying DNA regulatory elements on the basis of cryptographic techniques alone.

### Cell Differentiation of Cells in Tissue Culture

Researcher: Midshipman I/C Andrew Pelczar, USN

Adviser: Assistant Professor John W. Bodnar

A fertilized egg contains all the information necessary to determine the identity of an adult animal, and the process of organismal development depends on a series of biochemical events to express that information into structural components of the organism. The information for development is stored in a hierarchy of forms: molecular information in DNA; cellular information in cell nuclei; and organismal information in tissues throughout the growing organism. Therefore,

understanding the biochemistry of organismal development will require an integrated knowledge of biochemical pathways and compartmentalization of information at the molecular, cellular, and organismal levels. Knowledge of biological mechanisms for information access will not only provide a theoretical basis for understanding cancer and other diseases but also for formulating models to construct biochemical control systems. During the development of an

organism, individual cells must differentiate to form specific tissues which constitute the adult organism. Cellular division may cause the progeny to differ from their parent cell and each other. Therefore, an important step in studying cellular differentiation is to define a model system in which the fate of progeny cells can be followed as they grow and divide.

Most tissue culture cells are derived from cancer cells of specific organs. However, it is unclear if the tissue culture cells all grow and divide identically or whether there are specific cells (called stem cells) that produce the cells in the culture. To determine cell

division patterns, time lapse video microscopy was utilized to provide graphical data of tissue culture division patterns. Using digitized images of these video recordings the fate of all cells in the culture could be followed. In studies of two well studied tissue culture cell lines, one (HeLa cells) was determined to have symmetrical cell divisions but the other (KB cells) showed indications of stem cells within the population. Further study of the KB cells and other tissue culture lines should, therefore, provide a model system to study the biochemistry of cell division and differentiation during development.

## Applications of Genetic Algorithms to Crystal Structure Solution and Predication

Researchers: Midshipman 1/C Michael Spooner, USN

Adviser: Assistant Professor Wayne H. Pearson

Genetic Algorithms have been applied to a wide variety of problems ranging from complex biological systems to tactical missile strike planning. The use of genetic algorithms involves optimization of a system by allowing randomly selected solutions to generate and mutate with respect to fitness functions. Those solutions which give good agreement with the fitness function will continue to mutate until a satisfactory level of agreement is obtained. The goal of this study was to examine the usefulness of such algorithms in modeling crystal structures. As a first step, it was decided to examine simple ionic structures. Attempts

were made to predict the ionic structure of FCC NaCl by using the electrostatic potential energy as the fitness function.

This work remains uncompleted. Considerable progress was made in modifying existing genetic algorithm code to make it more applicable to the crystal structure solution problem. Difficulties with the generation of initial random solutions prevented the testing of the completed code.

Publication is planned in the crystallographic literature in the event that the use of these algorithms proves beneficial.

## Determination of Cadmium Concentration in Oyster Shells

Researcher: Midshipman 1/C Kevin Townsend, USN

Adviser: Professor Edward Koubek

By determining the Cadmium concentration in oyster shells from various time periods, it was hoped that it would be possible to trace the degree of industrial

pollution in the Chesapeake Bay during the past 100 years.

## Structure Determination of a Series of Diterpenes

Researcher: Midshipman 1/C R. Michael Viayra, USN

Adviser: Associate Professor Debra K. Dillner

The goal of this project is to determine the structure of a series of diterpenes. These compounds were isolated from a species of Verbena, *Verbena Officiannalis*, in Thailand.

Diterpenes are ubiquitous in nature. They are found in both plants and animals and have a variety of purposes. In humans, terpenes are common and include the steroids such as cholesterol. Many plant terpenes have medicinal uses. Taxol, a compound which is

currently undergoing clinical trials as a treatment for ovarian cancer, is a diterpene found in Yew trees of the Pacific Northwest.

The terpenes being studied in this project are under investigation for biological activity. However, currently the structure of these four compounds is not known. Various investigations will be carried out to elucidate the structures of these compounds.

The objective of this project is to carry out

spectroscopic studies on the four diterpenes. Information gained from these studies will assist in structural elucidation. The compounds being investigated are available in small quantities only. Each has been isolated in less than 50 mg quantities. Because of the limitations imposed by this, only spectroscopic studies can produce information needed to determine structure. The specific types of spectroscopy to be used are infrared, mass spectroscopy and a variety of Nuclear Magnetic Resonance (NMR) spectroscopic techniques.

The most useful of the initial spectroscopic techniques to be used on terpenes A, D, F and G was mass spectroscopy. Utilizing this technique, the chemical formulas of the four compounds were determined. This confirmed the assumption that all of these compounds are diterpenes. All four compounds contain 29 carbon atoms indicating that some rearrangement of the basic diterpene skeletal arrangement of 30 carbons has occurred.

This information was combined with information from proton and carbon-13 NMR studies to indicate that all four compounds are new diterpenes and have not previously been isolated from other plants. Particularly useful is the information that compound A contains six methyl carbons, with four having adjacent C-H groups. This eliminates all known diterpenes with the same chemical formula. The chemical formula also indicates that these compounds contain four carbocyclic

rings and one carbon-carbon double bond.

Literature searching for compounds with these features indicates that the most likely structure is similar to the steroidal ring system. However, the placement of the methyl groups on this framework is unique. Similar structure features were found for the other three diterpenes.

NMR spectroscopic studies are also being undertaken. Due to the carbocyclic skeleton, most of the resonances overlap in 1-dimensional and simple 2-dimensional experiments. These studies have given information about small fragments of the large structure.

Advanced 2-dimensional NMR studies are in progress. Investigators at the National Cancer Institute are obtaining the spectra. Some of these spectra are available and the task of interpretation has begun. Currently, long range Correlation Spectroscopy (COSY) studies and Heteronuclear Multi-quantum Coherence Spectroscopy (HMBC) spectra are being examined. To date, these have been useful in extending the fragments obtained from the simpler spectroscopic studies.

Examination of the spectral characteristics of these compounds is continuing. Efforts are being made to obtain these compounds in larger quantities. This would allow for use of a wider array of spectroscopic techniques, including the possibility of obtaining x-ray crystal structures.

## Publications

CAMPBELL, Mark L., Associate Professor, co-author, "A Simple, Systematic Method for Determining J Levels for jj Coupling," *Journal of Chemical Education*, 71 (June 1994), 457-463.

A process is described in which the J levels for a term can be simply and systematically determined for atoms described by jj coupling. A tabulation of the J levels for all terms derived from s<sup>n</sup>, p<sup>n</sup>, d<sup>n</sup> and f<sup>n</sup> electron configurations is presented. A discussion of the significance of the type of angular momentum coupling which predominates in an atom is presented in terms of measurable atomic parameters.

CAMPBELL, Mark L., Associate Professor, co-author, "Reaction Kinetics of Mo(a<sup>7</sup>S<sub>3</sub>, a<sup>5</sup>S<sub>2</sub>, a<sup>5</sup>D<sub>1</sub>, a<sup>5</sup>G<sub>1</sub>) with O<sub>2</sub>," *Chemical Physics Letters*, 235 (31 March 1995), 497-502.

The gas phase reactivities of Mo(a<sup>7</sup>S<sub>3</sub>, a<sup>5</sup>S<sub>2</sub>, a<sup>5</sup>D<sub>1</sub>, a<sup>5</sup>G<sub>1</sub>) with O<sub>2</sub> in the temperature range 297 - 620 K are reported. Mo atoms were produced by the

photodissociation of Mo(CO)<sub>6</sub> and MoCl<sub>4</sub> and detected by laser-induced fluorescence. The disappearance rates of all states are found to be pressure independent with argon buffer gas. The disappearance rate constants of the s<sup>1</sup>d<sup>5</sup> a<sup>7</sup>S<sub>3</sub>, a<sup>5</sup>S<sub>2</sub> and a<sup>5</sup>G<sub>1</sub> states are on the order of the gas kinetic rate constant. The s<sup>2</sup>d<sup>4</sup> a<sup>5</sup>D<sub>1</sub> states are not as reactive and are found to be temperature dependent. Results are discussed in terms of the different electron configurations of the states.

CHEEK, Graham T., Professor, "Proton Donor Characteristics of a Room-Temperature Molten Salt," *Proceedings of the Electrochemical Society*, PV 94-13 (1994) 426-432.

Evidence has been obtained that the ring protons of 1-ethyl-3-methylimidazolium chloride (EMIC) can act as proton donors towards electrochemically generated bases in the aluminum chloride : EMIC molten salt system. Reduction of benzophenone in the deuterated (2 position of EMIC) basic melt yields benzhydrol deuterated at the carbinol carbon, showing that the

intermediate carbanion is basic enough to be protonated by the EMI cation. Anthracene undergoes a two-electron reduction in the basic melt, giving dideuterioanthracene. Considering that both benzophenone and anthracene are not protonated in acetonitrile, these results indicate that the aluminum chloride : EMIC melt environment is considerably more acidic than are conventional solvents such as acetonitrile.

CHEEK, Graham T., Professor, "Quartz Crystal Microbalance Study of Platinum Amalgamation," *Proceedings of the Electrochemical Society*, PV 94-31 (1994) 186-192.

The electrochemical deposition of mercury onto platinum substrates has been studied using the quartz crystal microbalance. The frequency response at 5 MHz AT-cut crystals indicates that mercury forms a relatively thin Pt/Hg layer which blocks further mercury deposition. Studies have been carried out at both the Pt/Hg amalgam surface and thin mercury layers deposited onto the Pt/Hg layer. Iodide adsorption/desorption cycles have been observed on these surfaces, corresponding to expected behavior for monolayer interactions.

FITZGERALD, Jeffrey P., Associate Professor, co-author, "Electronic Distinction between Porphyrins and Tetraazaporphyrins. Insights from X-ray Photoelectron Spectra of Free Base Porphyrin, Porphyrazine, and Phthalocyanine Ligands," *Inorganic Chemistry*, 33 (1994), 6057-6060.

High-resolution nitrogen core X-ray photoelectron spectra are reported for free base octaethylporphyrin, octaethylporphyrazine, tetrabenzoporphyrin, and phthalocyanine. The spectra have been analyzed and assigned using all-electron *ab initio* Hartree-Fock calculations with basis sets of double- $\zeta$  or better quality. The results show that *meso*-tetraaza-substitution causes an increase of 0.20 - 0.45 eV in the core ionization potentials of the central nitrogens of porphyrin ligands, which implies a significantly more positive electrostatic potential in the central metal-binding region of a tetraazaporphyrin relative to a similarly substituted porphyrin.

FITZGERALD, Jeffrey P., Associate Professor, co-author, "Iron(II) Octaethyltetraazaporphyrin, FeOETAP, a Canted Ferromagnet with  $T_c = 5.6$  K," *Advanced Materials*, 6 (1994), 836-838.

A four-coordinate azaporphyrin, FeOETAP, is reported that has temperature and field-dependent properties different from those of other four-coordinate iron(II) porphyrins and related macrocycles, displaying

an apparent canted ferromagnetic state. This behavior is compared to that of other M(OETAP) where M = Mn, Co, Ni, Cu and Zn.

GOMBA, Frank J., Associate Professor, "Navy Shipboard Hazardous Material Minimization Program: Phase I Report: Cleaning Compounds and Solvents," CARDIVNSWC-TR-63-94/03, October 1994.

This report covers the use of cleaning compounds and solvents aboard U.S. Navy ships and submarines. It characterizes the uses, handling, storing, disposal, and recommended substitutes. A computer program for easy access by all ships was developed.

HARRISON, Judith A., Assistant Professor, "Simulated Tribochemistry: An Atomic-Scale View of the Wear of Diamond", *Journal of the American Chemical Society*, 116 (1994), 10399-10402.

Molecular dynamics simulations were used to explore the atomic-scale chemistry and associated wear that occurs when diamond surfaces were placed in sliding contact. The simulations predict complex radical chemistry initiated by the shearing of hydrogen atoms from chemisorbed molecules. Observed chemical mechanisms included hydrogen atom abstraction from surfaces, radical recombination, transient surface adhesion, and formation of debris at the interface. These simulations provide the first glimpse into the rich, nonequilibrium tribochemistry that occurs at diamond and related covalently-bonded interfaces.

KINTER, Christopher M., Assistant Professor, co-author, "Synthesis of N1'-([C-11]Methyl)Naltrindole: A Radioligand for Positron Emission Tomographic Studies of Delta Opioid Receptors". *Journal of Labelled Compounds and Radiopharmaceuticals*, Vol. XXXVI (1995), 137-145.

Evidence suggests the existence of three opioid receptor types ( $\mu$ ,  $\delta$ ,  $\kappa$ ). The delta receptor has been shown to play a role in neurodegenerative disorders such as Alzheimer's and Parkinson's disease, seizure disorders such as epilepsy, and the neurobiology of substance abuse. The ability to measure delta site density has the potential for positive impact in medical studies. Towards this end a delta opioid receptor antagonist, N1'-methylnaltrindole (MeNTI), has been labeled with the positron emitting isotope C-11. The precursor for radiolabeling was prepared in 71% yield by benzylation of the phenolic group of naltrindole. Alkylation of the N1'-indole nitrogen was accomplished using [C-11]-iodomethane and aqueous tetrabutylammonium hydroxide at 80°C. The alkylation step was directly followed by removal of the benzyl protecting group using standard hydrogenolysis conditions ( $H_2$ , over

10% Pd/C). The target compound, [C-11]MeNTI was purified by reverse phase HPLC and formulated for injection in buffered sterile saline. The average time for synthesis, purification, and formulation was 24 minutes from the end-of-bombardment. The [C-11]methyl naltrindole that was obtained was found to have an average specific activity of 2050 mCi/ $\mu$ mol and radiochemical yield (based on [C-11]iodomethane) of 6%. This compound is currently undergoing assessment as a ligand for the study of delta opiate receptors in seizure disorder patients.

MCCLEAN, Roy E., Assistant Professor, co-author, "Growth and Decay of Pb(7s  $^3P_1^0$ ) and Pb(7s  $^3P_0^0$ ) from the 193 nm Photodissociation of PbI<sub>2</sub> and PbBr<sub>2</sub>," *Journal of Physical Chemistry*, 99 (1995) 6580.

An investigation into the growth and decay of the 7s  $^3P_1^0$  and the 7s  $^3P_0^0$  states of atomic lead via atomic emission at 283.3, 364.0, 368.4, and 405.8 nm following the 193 nm photodissociation of PbI<sub>2</sub>(g) and PbBr<sub>2</sub>(g) is reported. The kinetics of these states were studied as a function of lead dihalide pressure, buffer gas pressure, cell temperature, and laser fluence. Three growth and decay mechanisms, giving three peaks of intensity vs. time, were identified that overlapped and sometimes coincided in time. In the fastest mechanism, the temporal behavior of the Pb excited state populations followed the photolysis pulse (fwhm = 15 ns) intensity. In the intermediate time mechanism, the Pb excited state populations appear to grow and decay with equal specific rates of  $\sim 10^7$  s<sup>-1</sup>. The slowest mechanism appears to involve collisions with lead dihalides for both the growth and decay. Some possible mechanisms are proposed.

MCCLEAN, Roy E., Assistant Professor, co-author, "Reaction Kinetics of Mo( $a^7S_3$ ,  $a^5S_2$ ,  $a^5D_1$ ,  $a^5G_1$ ) with O<sub>2</sub>," *Chemical Physics Letters*, 235 (1995) 497.

The gas phase reactivities of Mo( $a^7S_3$ ,  $a^5S_2$ ,  $a^5D_1$ ,  $a^5G_1$ ) with O<sub>2</sub> in the temperature range 297 - 620 K are reported. Mo atoms were produced by the photodissociation of Mo(CO)<sub>6</sub> and MoCl<sub>4</sub> and detected by laser-induced fluorescence. The disappearance rates of all states are found to be pressure independent with argon buffer gas. The disappearance rate constants of the s $^2$ d $^4$   $a^7S_3$ ,  $a^5S_2$  and  $a^5G_1$  states are on the order of the gas kinetic rate constant. The s $^2$ d $^4$   $a^5D_1$  states are not as reactive and are found to be temperature dependent. Results are discussed in terms of the different electron configurations of the states.

PEARSON, Wayne H., Assistant Professor, co-author, "Instability of 15-electron Cp<sup>\*</sup>MoCl<sub>2</sub>L(L=2-electron donor) derivatives. X-ray structure of Cp<sup>\*</sup>MoCl<sub>2</sub>(PMe<sub>2</sub>Ph)<sub>2</sub> and [Cp<sup>\*</sup>MoCl<sub>2</sub>(PMe<sub>2</sub>Ph)<sub>2</sub>]AlCl<sub>4</sub>,"

*Journal of Organometallic Chemistry*, 488 (1995) 29-38.

The complex Cp<sup>\*</sup>MoCl<sub>2</sub>(PMe<sub>2</sub>Ph)<sub>2</sub> (Cp<sup>\*</sup> = h<sup>5</sup>C<sub>5</sub>Me<sub>5</sub>) has been obtained in good yields from Cp<sup>\*</sup>MoCl<sub>4</sub>, PMe<sub>2</sub>Ph<sub>2</sub>, and Na in the appropriate stoichiometric ratio, and is also obtained by a ligand redistribution process after reduction of Cp<sup>\*</sup>MoCl<sub>3</sub>-(PMe<sub>2</sub>Ph) with Na. This compound is oxidized by CH<sub>2</sub>Cl<sub>2</sub> solvent in the presence of AlCl<sub>3</sub> to afford the salt [Cp<sup>\*</sup>MoCl<sub>2</sub>(PMe<sub>2</sub>Ph)<sub>2</sub>]AlCl<sub>4</sub>. Both compounds have been characterized crystallographically and by <sup>1</sup>H-NMR spectroscopy. The reasons for the instability of 15-electron Cp<sup>\*</sup>MoCl<sub>2</sub>L complexes are discussed. The <sup>1</sup>H-NMR resonance data for Cp<sup>\*</sup>MoCl<sub>2</sub>L<sub>2</sub> (L=PMe, PMe<sub>2</sub>Ph) and [Cp<sup>\*</sup>MoCl(PMe<sub>2</sub>Ph)]<sup>+</sup> are also discussed.

SHADE, Joyce E., Associate Professor, Wayne H. PEARSON, Assistant Professor, and Midshipman 1/C James E. BROWN, USN "Photochemical Reimer-Tiemann Reactions of ( $\eta^5$ -C<sub>5</sub>H<sub>5</sub>)<sub>2</sub>Fe<sub>2</sub>( $\mu$ -CO)<sub>2</sub>( $\mu$ -Ph<sub>2</sub>PCH<sub>2</sub>PPh<sub>2</sub>) and ( $\eta^5$ -C<sub>5</sub>H<sub>5</sub>)<sub>2</sub>Fe<sub>2</sub>( $\mu$ -CO)<sub>2</sub>( $\mu$ -Ph<sub>2</sub>PCH<sub>2</sub>CH<sub>2</sub>PPh<sub>2</sub>). Molecular Structures of ( $\eta^5$ -C<sub>5</sub>H<sub>5</sub>)<sub>2</sub>Fe<sub>2</sub>( $\mu$ -CO)<sub>2</sub>( $\mu$ -Ph<sub>2</sub>PCH<sub>2</sub>CH<sub>2</sub>PPh<sub>2</sub>) and ( $\eta^5$ -CHOC<sub>5</sub>H<sub>4</sub>)( $\eta^5$ -C<sub>5</sub>H<sub>5</sub>)Fe<sub>2</sub>( $\mu$ -CO)<sub>2</sub>( $\mu$ -Ph<sub>2</sub>PCH<sub>2</sub>CH<sub>2</sub>PPh<sub>2</sub>)," *Organometallics*, 14 (1995) 157-161.

Photolysis of either ( $\eta^5$ -C<sub>5</sub>H<sub>5</sub>)<sub>2</sub>Fe<sub>2</sub>( $\mu$ -CO)<sub>2</sub>( $\mu$ -DPPM) (DPPM = Ph<sub>2</sub>PCH<sub>2</sub>PPh<sub>2</sub>), I, or ( $\eta^5$ -C<sub>5</sub>H<sub>5</sub>)<sub>2</sub>Fe<sub>2</sub>( $\mu$ -CO)<sub>2</sub>( $\mu$ -DPPE) (DPPE = Ph<sub>2</sub>PCH<sub>2</sub>CH<sub>2</sub>PPh<sub>2</sub>), II, in CHCl<sub>3</sub> followed by chromatography on wet alumina results in the formation of products in which one cyclopentadienyl ring has been formulated. In contrast, photolysis of ( $\eta^5$ -C<sub>5</sub>H<sub>5</sub>)<sub>2</sub>Fe<sub>2</sub>( $\mu$ -CO)<sub>2</sub>( $\mu$ -DPPP), III, under analogous conditions gives the chloride derivative expected from Fe-Fe bond homolysis. Available evidence suggests that the reactions of I and II proceed via a photochemical Reimer-Tiemann reaction involving an irreversible charge transfer to yield the respective radical cation and a dichloromethyl radical. Subsequent coupling of these radicals forms a ring-substituted dichloromethyl intermediate which is in turn hydrolyzed to the aldehyde upon workup. Formyl derivatives have been fully characterized by IR, <sup>1</sup>H, <sup>13</sup>C, and <sup>31</sup>P NMR, mass spectrometry, and elemental analysis. Reaction of [( $\eta^5$ -C<sub>5</sub>H<sub>5</sub>)<sub>2</sub>Fe<sub>2</sub>( $\mu$ -CO)<sub>2</sub>( $\mu$ -DPPM)]PF<sub>6</sub>, I<sup>+</sup>PF<sub>6</sub><sup>-</sup>, with  $\frac{1}{2}$  ICH<sub>2</sub>CCl<sub>2</sub>CH<sub>3</sub>, under conditions known to generate the alkyl radical, yielded the ring substituted compound ( $\eta^5$ -C<sub>5</sub>H<sub>4</sub>CH<sub>2</sub>CO<sub>2</sub>C<sub>2</sub>H<sub>5</sub>)(C<sub>5</sub>H<sub>5</sub>)Fe<sub>2</sub>( $\mu$ -CO)<sub>2</sub>( $\mu$ -DPPM), providing additional support for a radical pathway to ring substitution in these compounds. The molecular structures of ( $\eta^5$ -C<sub>5</sub>H<sub>5</sub>)<sub>2</sub>Fe<sub>2</sub>( $\mu$ -CO)<sub>2</sub>( $\mu$ -DPPE), II, and ( $\eta^5$ -CHOC<sub>5</sub>H<sub>4</sub>)( $\eta^5$ -C<sub>5</sub>H<sub>5</sub>)Fe<sub>2</sub>( $\mu$ -CO)<sub>2</sub>( $\mu$ -DPPE), V, have been characterized by X-ray crystallography.

URBAN, Joseph J., Assistant Professor, co-author, "Effect of Fluorine Substitution on Phenol Acidities in the Gas Phase and in Aqueous Solution. A Computational Study Using Continuum Solvation Models," *Journal of Organic Chemistry*, 59 (18), (September 1994), 5239-5245.

The effect of fluorine substitution on the gas and aqueous phase acidity of the monofluorophenols has been investigated with a combination of computational techniques. The effects of aqueous solvation were included using the SM2, SM3 and GB/SA continuum solvation models. These solvation models produce

calculated free energies of hydration that are in good agreement with the available experimental data and appear to be quite useful for the prediction of the solvent effects on the relative acidities of the fluorophenols with respect to phenol. A thorough analysis of the charge distribution in the gas and aqueous phase provides insight into the nature of the experimentally observed solvent attenuation of substituent effects for these compounds. While fluorine substitution increases the hydrophobicity of the phenols and phenoxides, the perturbation of ring charge density imparted by fluorine substitution is quite similar in the gas phase and aqueous phases.

## Presentations

BODNAR, John W., Assistant Professor, "Programming the Drosophila Embryo: Simulation of Pattern Formation Using a Personal Computer," Theoretical Biology and Biomathematics Gordon Conference, Tilton, New Hampshire, June 1994.

BODNAR, John W., Assistant Professor, "The Evolution of Complex Systems," Chemistry Department Faculty Research Seminar, United States Naval Academy, Annapolis, Maryland, 7 November 1994.

CAMBELL, Mark L., Associate Professor, "Gas Phase Metal Atom Reactions," Chemistry Department Faculty Research Seminar, United States Naval Academy, Annapolis, Maryland, 27 March 1995.

CAMBELL, Mark L., Associate Professor, "Reaction Kinetics of W(a5DJ,7S3) with O<sub>2</sub> from 296-600 K," 209th National Meeting of the American Chemical Society, Anaheim, California, 5 April 1995.

CHEEK, Graham T., Professor, "Quartz Crystal Microbalance Study of Platinum Amalgamation," 208th National Meeting of the American Chemical Society, Washington, DC, 24 August 1994.

CHEEK, Graham T., Professor, "Quartz Crystal Microbalance Study of Platinum Amalgamation," 186th Electrochemical Society Meeting, Miami Beach, Florida, 13 October 1994.

CHEEK, Graham T., Professor, "Initial Investigations into the Acetonitrile/Aluminum Chloride Solvent System," Gordon Conference on Electrochemistry, Ventura, California, 18 January 1995.

CHEEK, Graham T., Professor, "Quartz Crystal Microbalance Studies of Methanol Oxidation at

Platinum," 187th Electrochemical Society Meeting, Reno Nevada, 25 May 1995.

CHEEK, Graham T., Professor, "Investigation in Molten Salt Electrochemistry," Chemistry Department Faculty Research Seminar, United States Naval Academy, Annapolis, Maryland, 5 December 1995.

ELERT, Mark L., Professor, "Molecular Dynamics Study of the Reaction Zone in Condensed-Phase Detonation," American Physical Society National Meeting, San Jose, California, 20-24 March 1995.

ELERT, Mark L., Professor, "Molecular Dynamics Simulations of Detonation," Chemistry Department Faculty Research Seminar, United States Naval Academy, Annapolis, Maryland, 27 February 1995.

FERRANTE, Robert F., Associate Professor, "Laboratory Studies of Formaldehyde Polymerization in Cometary Ice Analogues," 26th Annual Meeting, American Astronomical Society, Division for Planetary Sciences, Bethesda, Maryland, 2 November 1994.

FERRANTE, Robert F., Associate Professor, "Infrared Study of Laboratory Ices Containing Methanol," 26th Annual Meeting, American Astronomical Society, Division for Planetary Sciences, Bethesda, Maryland, 2 November 1994.

FERRANTE, Robert F., Associate Professor, "Laboratory Studies of Cometary Ice Analogues," Chemistry Department Faculty Research Seminar, United States Naval Academy, Annapolis, Maryland, 13 March 1995.

FERRANTE, Robert F., Associate Professor, co-author, "Effects of Ion Irradiation and Silicate Surfaces on the Infrared Spectra of Cometary-Type Ices,"

International Colloquium on Solar System Ices, Toulouse, France, 28 March 1995.

HARRISON, Judith A., Assistant Professor, "Atomic-Scale Friction and Wear of Diamond Surfaces," Gordon Conference on Tribology, Plymouth, New Hampshire, 3-8 July 1994.

HARRISON, Judith A., Assistant Professor, "Investigation of Atomic-Scale Processes in Hydrocarbon Systems using Molecular Dynamics," The George Washington University, Washington, DC, 21 October 1994.

HARRISON, Judith A., Assistant Professor, "Investigation of Atomic-Scale Processes in Hydrocarbon Systems using Molecular Dynamics," Yale University, New Haven, Connecticut, 28 October 1994.

HARRISON, Judith A., Assistant Professor, "Investigation of Atomic-Scale Processes in Hydrocarbon Systems using Molecular Dynamics," Chemistry Department Faculty Research Seminar, United States Naval Academy, Annapolis, Maryland, 31 October 1994.

HARRISON, Judith A., Assistant Professor, "Molecular Dynamics Investigations of Indentation, Adhesion, Friction, and Wear," University of Maine, Orono, Maine, 19 December 1994.

HARRISON, Judith A., Assistant Professor, "Adhesion between Hydrocarbon Surfaces: a Molecular Dynamics Study," 18th Annual Meeting of the Adhesion Society, Hilton Head, South Carolina, 19-22 February 1995.

HARRISON, Judith A., Assistant Professor, "Molecular Tribology of Hydrocarbon Systems," 209th American Chemical Society National Meeting, Anaheim, California, 2-7 April 1995.

HEUER, William B., Assistant Professor, "An IR and MW Spectroscopy Experiment for the Beginning Laboratory," American Chemical Society 13th Biennial Conference on Chemical Education, Lewisburg, Pennsylvania, 2 August 1994.

HEUER, William B., Assistant Professor, "Molecular Solid State Chemistry," Chemistry Department Faculty Research Seminar, United States Naval Academy, Annapolis, Maryland, 3 October 1994.

KOUBEK, Edward, Professor, "An Investigation into the Absorption of IR Light by Small Molecules: A General Chemistry Experiment," 13th Biennial Conference on Chemical Education, Lewisburg,

Pennsylvania, 31 July 1994.

LOMAX, Joseph F., Associate Professor, Wayne H. PEARSON, Assistant Professor, Mary C. WINTERSGILL, Professor, (Physics) and John J. FONTANELLA, Professor, (Physics), "Zr- $\beta$ -alumina: Synthesis, X-Ray Crystal Structure and Dielectric Measurements," Solid State Ionics Gordon Conference, New London, New Hampshire, 29 June 1994.

McCLEAN, Roy, E., Assistant Professor, "Chemical Reactivity of Transition Metal Species in the Gas Phase: Oxidation Kinetics of Ti, V, & Mo," New Mexico State University, Las Cruces, New Mexico, 27 October 1994.

McCLEAN, Roy, E., Assistant Professor, "Chemical Reactivity of Transition Metal Species in the Gas Phase: Oxidation Kinetics of Ti, V, & Mo," Chemistry Department Faculty Research Seminar, United States Naval Academy, Annapolis, Maryland, 21 November 1994.

PEARSON, Wayne H., Assistant Professor, "Getting More than Geometry from X-ray Diffraction", seminar presented at the University of Maryland, College Park, Maryland, 25 January 1995.

PEARSON, Wayne H., Assistant Professor, "Studies in X-Ray Crystallography," Chemistry Department Faculty Research Seminar, United States Naval Academy, Annapolis, Maryland, 10 October 1994.

PEARSON, Wayne H., Assistant Professor, John W. Schultz, Professor, "The Use of Spreadsheets in the Chemistry Curriculum," 208th National Meeting of the American Chemical Society, Washington, DC, 25 August 1994.

PEARSON, Wayne H., Assistant Professor, "Data Refinement in X-ray Crystallography," University of Missouri, Columbia, Missouri, 29 July 1994.

PEARSON, Wayne H., Assistant Professor, "Fundamentals of X-ray Crystallography," REU Lecture Series, University of Missouri Research Reactor, Columbia, Missouri, 13 July 1994.

SHADE, Joyce E., Associate Professor, co-author, "Synthesis and Chemistry of Pentaphenylcyclopentadienyl Derivatives of Molybdenum and Tungsten Carbonyls," 208th National Meeting of the American Chemical Society, Washington, DC, 21 August 1994.

SHADE, Joyce E., Associate Professor, "A Facile Synthesis of Heterobimetallic Compounds Containing



Ruthenium," 209th National Meeting of the American Chemical Society, Anaheim, California, 2 April 1995.

SIATKOWSKI, Ronald E., Assistant Professor, "Wines for this Evening's Celebration," United States Naval Academy and the Navy Surface Warfare Center, Annapolis Division, Chapter of Sigma Xi, Bancroft Hall, United States Naval Academy, Annapolis, Maryland, 10 May 1995.

URBAN, Joseph J., Assistant Professor, "Ab Initio Analysis of the Conformations of Lewisite Using

Effective Core Potentials," 209th National Meeting of the American Chemical Society, Anaheim, California, 3 April 1994

WAITE, Boyd A., Professor, "A Diffusion Kinetics Model for Describing Fiber Optics-based Biosensors," Chemistry Department Faculty Research Seminar, United States Naval Academy, Annapolis, Maryland, 2 May 1995.

# Computer Science

Commander Leroy G. Williams, USN  
Chair

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During the 1994-1995 academic year, the Computer Science Department continued to conduct important research and spread the Academy's name through publishing. Civilian faculty members have developed close ties with local research institutes. Dr. Patrick Harrison and Dr. Kay Schulze work closely with the Naval Research Laboratory, and Dr. Frank Chi is affiliated with the Defense Mapping Agency.

Student research has also prospered. Dr. Andrew Phillips once again mentored a Trident

Scholar, Midn 1/C Wesley Hildebrandt. His research is entitled *Optimization of Linearly Constrained Indefinite Functions*. Midn Hildebrandt was awarded the coveted Harry E. Ward Trident Scholar Award for the best Trident report.

Considering the small number of civilian faculty, the Computer Science Department had an extremely productive year. Overall, there were 15 publications and 20 presentations.

## Sponsored Research

### Computer Graphics Modeling

Researcher: Professor Frank L.K. Chi

Sponsor: Defense Mapping Agency

Computer graphics seeks to represent physical objects in realistic and efficient models. In recent years, many representational methods have been proposed. No single "perfect" modeling method has emerged, but rather a variety of methods that are each suited for specific types of problems or objects.

This project explores the various methods of

representing objects for computer applications, presenting the strengths and weaknesses of each method. Specifically, the following models will be studied in detail: surface and boundary models such as polygons, graftals, and curved surfaces; volume and constructive solid geometry (CSG) models such as Voxels and Oct-trees.

### Advances in Case-Based Reasoning (Program of Research)

Researcher: Professor Patrick R. Harrison

Sponsor: Office of Naval Research

Case-based reasoning (CBR) tools are now commonly used to assist in developing decision aids for help-desk, diagnosis, and other applications. However, for application to large-scale, real-time planning, strategic and tactical situation assessment and other complex domains critical to the Navy, current CBR technology needs to be extended in a variety of ways. In particular, progress is needed in verification and validation, indexing of case memories, reasoning about case similarity, case adaptation and the integration of varieties of case representation. On-going 6.1 research is addressing these issues has been growing rapidly, and the Office of Naval Research (ONR) basic research

program in Intelligent Systems has a long-term commitment to supporting such research. This research program is providing the larger scope 6.2 effort that is needed to evaluate and transition the 6.1 results that currently need attention and new ones as they emerge.

CBR systems rarely can solve complex problems in a stand-alone mode. Rather, they must be integrated with and embedded in other tools. Therefore, CBR practitioners must have access to tools that address practical issues in the course of building their applications, such as the ability to identify and consider the merits of alternative forms of case representation and reasoning; in particular, Navy needs

for cost-effective system development would benefit from innovative CBR tools offering prototyping and simulation support. This program includes building,

demonstrating and eventually disseminating such next-generation tools.

## **Agent Based Case-Based Reasoners**

Researcher: Professor Patrick R. Harrison

Sponsor: Naval Research Laboratory

The *Case-Based Agent* is characterized by mining, relevance filtering, and display operations involving massive data repositories to support Naval personnel in decision making tasks. The research focuses on using novel extensions of distributed *case-based reasoning* technology embedded in a framework with tools to support user modeling and information display. The core of this research concerns using an array of domain-

specific case-based agents for context-sensitive mining and relevance filtering tasks. These agents use a common representation language to enhance communication among the agents, an intelligent indexing scheme to support real-time information processing, and apply recent advances in verification and validation technology to ensure that the needs of the task and user are correctly addressed.

## **Computational Solutions for Protein Structure Prediction**

Research: Associate Professor Andrew T. Phillips

Sponsor: Minnesota Supercomputer Institute

This research project involves the study of solution methods for the protein structure prediction problem. The protein structure prediction, or protein folding, problem attempts to predict the native, or folded, state of a protein in three-dimensional space, given its primary sequence of amino acids. One common approach for a solution is to treat each complex amino acid as a single sphere, or "united atom," and to model each peptide linkage between residues by a virtual bond between spheres. Computational efforts being examined rely on two major assumptions: 1) for any specific molecular conformation, a corresponding potential energy function can be computed, and 2) the three-dimensional, folded state corresponds to the global minimum of this energy function. The optimization method being used to minimize the

potential energy involves collecting a large number of conformers, each attained by finding a local minimum of the potential energy function from a random starting point. The information from these conformers is then used to form a convex quadratic global underestimating function for the potential energy of the known conformers. The minimum of this under estimator is used to predict the global minimum for the function, allowing a localized conformer search to be performed based on the predicted minimum. The new set of conformers generated by the localized search can serve as the basis for another quadratic underestimation. After several repetitions, the global minimum can be found with reasonable assurance. The conformer which lies at the global minimum represents the three-dimensional folded state of the molecule.

## **Optimization of Linearly Constrained Indefinite Functions**

Researcher: Associate Professor Andrew T. Phillips

Sponsor: Office of Naval Research

Global optimization is the process of finding a *best* solution among many possible solutions to a problem involving the minimization or maximization of some desired "cost" function. In general, many problems arising from practical applications can be formulated using both an objective function to be optimized (cost, profit, etc.) and a set of restrictions on the allowed solutions. In some cases this objective function may be linear, in which case the problem may yield to linear programming techniques. In other cases it may be

entirely concave or convex. In these cases the solution may again be easy to obtain since certain properties of the function allow special searching techniques to locate the optimum solution. In the hardest cases the objective function is indefinite, which means that it can have many local minima, none of which satisfy any special properties. Furthermore, these problems are usually bounded by constraints, which restrict the allowed values of the individual variables. In the majority of real problems the constraints will be linear,

in which case the optimization problem can be approached using matrix algebra techniques. This project investigates two methods for optimizing

indefinite functions with linear constraints, and presents computational results obtained using each method.

## Reducing Human Dialogue in Structured Navy Teams

Researcher: Associate Professor Kay G. Schulze

Sponsor: Naval Research Laboratories

Verbal communication is a crucial aspect of the Command and Control environment and can frequently be so heavy as to overwhelm the entire Combat Information Center (CIC) process. We began this research to identify verbal communication that could possibly be eliminated or transferred to the computer interface in order to reduce the verbal communication traffic. This traffic can be viewed as a dialogue

between the user and the computer. The current research will continue a long range investigation and will consist of designing and implementing studies that will determine the feasibility of transferring or eliminating certain specific verbal communication classifications. It will then begin studies to determine the impact this might have on overall CIC performance.

## Independent Research

### Enhancement of a Color Image Quantization

Researcher: Instructor Paula J. Reitan

Heckbert's algorithm for adaptive, tapered color image quantization is enchanted. The research is motivated by the desire to display color images with greater precision than is computationally feasible with Heckbert's algorithm. The color image quantization process is decomposed into four steps:

- 1) Sample the original image to create a histogram of its color distribution.

- 2) Select a colormap based on the color distribution of the original image

- 3) Compute a quantization mapping from the colors in the image to the colors in the colormap

- 4) Quantize and display each pixel in the original image.

The algorithm enchanted. *Mean Volume Cut*, is a variation of a color image quantization algorithm first described by Paul Heckbert. It uses a 3-dimensional

array to store the histogram, requiring an array of size  $2^p$ , where  $p$  is the number of bits of color precision in each of the three color directions. For better running times, Heckbert suggests considering only the 5 high order bits of color precision when  $p > 5$ .

We show that the color image quantization process can be significantly degraded by not considering all bits of color precision. We propose a new algorithm which uses an Adelson-Velskii and Landis (AVL) tree to store the histogram, thus enabling all bits of color precision to be used. We show that our algorithm significantly reduces the quantization error of *Mean volume cut* with  $p = 5$ . Our algorithm is significantly slower than *Mean Volume Cut* with  $p=5$ , but significantly faster than *Mean Volume Cut* with  $p=8$ .

## Research Course Projects

### Interactive Course Support Using the World Wide Web

Researcher: Midshipman 3/C Michael Hingst

Adviser: Professor Patrick R. Harrison

The purpose of this research project is to design and implement the Principles of Artificial Intelligence course using the World Wide Web as media. Work is

being done on a summer internship at the Naval Research Laboratory Artificial Intelligence (AI) center. The work is sponsored by the AI center.

## Optimization of Linearly Constrained Indefinite Functions

Researcher: Midshipman 1/C Wesley A. Hildebrandt

Adviser: Associate Professor Andrew T. Phillips

Global optimization is the process of finding a best solution to a problem involving the minimization or maximization of some desired "cost" function. In general, many problems arising from practical applications can be formulated using both an objective function to be optimized (cost, profit, etc.) And a set of restrictions on the allowed solutions. In some cases this objective function may be linear, in which case the problem may yield to linear programming techniques. In other cases it may be entirely concave or convex. In these cases the solution may again be easy to obtain since certain properties of the function allow special searching techniques to locate the optimum solution. In

the hardest cases the objective function is indefinite, which means that it can have many local minima, none of which satisfy any special properties. Furthermore, these problems are usually bounded by constraints, which restrict the allowed values of the individual variables. In the majority of real problems the constraints will be linear, in which case the optimization problem can be approached using matrix algebra techniques. This project investigates two methods for optimizing indefinite functions with linear constraints, and presents computational results obtained using each method.

## Publications

HARRISON, Patrick R., Professor, co-authors, "Extension of Off-Nadir View Angles for Directional Sensor Systems," *Remote Sensing of Environment*, 1994, 50, pp 201-211.

A knowledge-based system called VEG was expanded to infer nadir or any off-nadir reflectance(s) of a vegetation target given any combination of other directional reflectance(s) of the target for a constant sun angle. VEG determines the best techniques(s) to use in an array of techniques, applies the techniques(s) to the target data, and provides a rigorous estimate of the accuracy of the inference(s). The knowledge-based system VEG facilitates the use of diverse knowledge bases to be incorporated into the inference techniques. In this study, VEG used additional information to make more accurate view angle extension techniques than the traditional techniques that only use spectral data from the unknown target in a simplistic manner. VEG used spectral data and a normalized difference technique to infer the percent ground cover of the unknown target. This estimate of percent ground cover of the unknown target along with information on the sun angle were then used to search a historical data base for targets that match the unknown target in these characteristics. This data captured the general shape of the reflectance distribution of the unknown target. This historical information was used to estimate the coefficients of the techniques for the conditions at hand and to test the accuracy of the techniques.

HARRISON, Patrick R., Professor, co-author, "Intelligent Workbench for Studying Earth's Vegetation," 1995, *Expert Systems with Applications*, 1995, Vol. 9; No. 2; pp 135-151.

The purpose of this paper is to describe VEG, an intelligent workbench for remote sensing scientists. VEG assists scientists in the analysis of optical reflectance data. VEG was designed to manage complexity, provide intelligent support, provide visualization tools and contract the time required for a scientist studying the earth's vegetation to run exploratory studies, test alternative hypotheses, do what if thinking and manage large data sets. VEG organizes and provides coherence to a diverse set of techniques and tools that are used by these scientists. It codifies in knowledge-based system components, heuristic knowledge used by these scientists when doing scientific work. The VEG system saves the scientists many hours of laborious calculation, and it empowers the scientist by allowing him or her to work quickly at a higher level of abstraction without the need to focus attention on a multitude of low level tasks. The VEG system includes rule-based components, data management tools, technique design and management tools, browsers, graphics support, a highly visual interface and a system for organizing and managing problem histories.

HARRISON, Patrick R., Professor, co-author,

"Validating an Embedded Intelligent Sensor Control System," *IEEE Expert*, June 1994, 2(3), pp 49-53.

This paper addresses the question of the design and validation of knowledge-based systems (KBS) that are real-time, require model-based reasoning and are embedded in sensor control systems. The paper demonstrates that for this class of applications, approaching KBS design and validation within an intelligent control framework provides a basis for both KBS design and validation. A developed application for intelligent, sensor control on a high speed avionics platform is used to illustrate the concepts. This system was developed and tested in both KEE and PROKAPPA.

Harrison, Patrick R., co-author, "Knack: An Adaptive Case-Based Reasoning Tool," In Press as a Technical Report, 1995.

This paper describes the Knack tool for case-based reasoning. Knack facilitates case retrieval and indexing based on adaptive methods. Retrieval is done using nearest neighbor and Bayesian methods with weighted attributes. In dynamic environments, the weights of attributes varies with time. Hence, its value need be automatically updated in response to environmental change. New indices or cases are generated by using clustering methods. Cases are then re-organized using the new indices. The Knack system integrates classification and clustering technologies for use in studying indexing, retrieval and models of memory.

PARK, Eun K., Associate Professor, co-author, "Automatic Error Detection in Distributed Systems," *Proceedings of ACM/Computer Science Conference '95*, February 1995, Nashville, Tennessee, pp.30-35.

Debugging in a distributed environment is very complex when compared to debugging in a uniprocessor or sequential environment. The order of events in a distributed environment is not deterministic, and this order of events may some times produce some unexpected errors. These errors which depend on the timing of events are typical of distributed systems. In this paper we proposed an approach based on the timing graphs concept to debug these timing errors. Here we give some conditions which should be satisfied by a timing graph, if the execution of that instance of the program, from which the graph is constructed, doesn't have any errors. The graphs are constructed using the information gathered at the run time using tracing mechanism. This approach uses topological sorting of directed acrylic graphs in analyzing the timing graphs. In this paper, we have developed the theory behind this approach and presented an algorithm to automate the procedure. Since the manual approach to this problem

is cumbersome and error prone, this automatic error detection procedure simplifies the detection of the cause of the error for some standard error patterns.

PARK, Eun K., Associate Professor, co-author, "Software Reuse System: An AI Based Approach," *Journal of Systems and Software*, Vol. 27, No. 3, December 1994, pp. 207-221.

The concept of software reusability is examined from the perspective of classifying and accessing reusable software. To improve the practicality of software reuse, one has to have a knowledge of its location, an understanding of the reusable components, and its adaptability to a particular need. The current state-of-the-art methods are assessed, and a new system for performing classification-based reuse is proposed. The concepts of subsumption and closeness introduced in [Prieto-Diaz 1987] are used to model function composition and function modification in software construction. These concepts and their associated metrics are used by the proposed reuse system to facilitate searching for reusable components and to provide capabilities for helping programmers to assess the worth of reusing particular packages. A description of the major algorithms required to compute these metrics is given. A sample user/system interaction which illustrates how these components and metrics are used to retrieve reusable components is presented. Also, domain analysis which helps in deciding whether a particular application is oriented towards software reuse is given.

PARK, Eun K., Associate Professor, co-author, "Encapsulation of ATM Cell Connection," *Proceedings of IEEE ICCCN94*, September 1994, San Francisco, California, pp. 207-211.

The goal of this research is to provide a framing structure for a sequence of ATM cells, which carry multimedia traffic. We will re-define the concept of a connection in the context of cell streams, show how to identify the starting and ending points of connections, and investigate the signaling and hardware support. A new Multimedia Application Adaptation Layer (MAIL) protocol is proposed as an application of this concept. The resolution technique being proposed may reduce the processing overhead when cells travel through the switches. Furthermore, it may simplify the traffic scheduling at the application level and re-synchronize the multimedia traffics through the Asynchronous Transfer Mode network interface.

PARK, Eun K., Associate Professor, co-author, "Intelligent Query Answering in Deductive and Object-Oriented Databases," *Proceedings of ACM CIKM94*, December 1994, Washington, DC, pp. 244-251.

In the near future, we believe that we will need much more sophisticated answer-finding schemes in an object-oriented database in order to satisfy the needs of truly intelligent information system. In this paper, we introduce a method to apply the intentional query processing techniques of deductive databases to object-oriented databases. So, we can generate intentional answers to represent answer-set abstractly for a given query in object-oriented databases.

Our approach consists of four steps: rule generation, pre-resolution, resolution, and post-resolution. In rule generation, we generate a set of deductive rules based on an object-oriented database schema. In pre-resolution, rule transformation is done to get unique intentional literals and extended term-restricted rules. In resolution, we identify rules that are potentially relevant to a query. In post-resolution, we find relevant resolvents as candidates for intentional answers among potentially relevant resolvents. We also use the notion of potentially relevant resolvents and relevant resolvents to avoid generating certain meaningless intentional answers.

PARK, Eun K., Associate Professor, co-author, "Towards a Framework for Integrating Multilevel Secure Models and Temporal Data Models," *Proceedings of ACM CIKM94*, December 1994, Washington, DC, pp. 280-287.

Within many organizations the number of databases containing classified or otherwise sensitive data is increasing rapidly. Access to these databases must be restricted and controlled to limit the unauthorized disclosure, or malicious modification of data contained in them. However, the conventional models of authorization that have been designed for database systems supporting the hierarchical, network and relational models of data do not provide adequate mechanisms to support controlled access of temporal objects and context based temporal information. In this paper we extend the multilevel secure relational model to capture the functionality required of a temporal database, i.e. a database that supports some aspect of time, not counting user-defined time. In particular we assign class access to bitemporal time stamped attributes, and give explicit security classifications to temporal elements.

PARK, Eun K., Associate Professor, co-author, "Performance Simulation of Hybrid-Ethernet," *International Journal of Computer Simulation*, Vol. 4, No. 3, Fall 1994, pp. 343-371.

Design, standardization, and implementation of local area networks (LANs) receive a considerable amount of effort from the world of computing today. The simple

linear bus or ring topologies (Ethernet, Token Bus, and Token Ring) have formed the basis for most of the work with LANs. However, there are significant disadvantages in certain applications of the linear bus and ring topology networks.

Recently, we proposed a new hybrid architecture local area network, Hybrid-Meshnet. The Hybrid-Meshnet allows an insertion and/or deletion of data links into/from existing local area networks: Ethernet or token ring. Earlier, our work has been concentrated on a token ring with connected data links. Our purpose of this article is to investigate another Hybrid-Meshnet architecture, Hybrid-Ethernet. Hybrid-Ethernet is a dual-channel structure, an Ethernet and a data channel. While the data channel is a collection of a full-duplex data links, the Ethernet is a modification of ANSI/IEEE LAN Standard 802.3. This architecture provides an insertion of direct data links, which not only allows secure and/or interactive communications between node pairs, but also improves overall network performance. To measure the performance improvement of Hybrid-Ethernet over a pure Ethernet, we developed an event-driven simulation model. Results of these measurements indicate that a small increase in link cost for data links can significantly enhance Hybrid-Ethernet performance over a pure Ethernet before the insertion of the data links.

PARK, Eun K., Associate Professor, co-author, "An Efficient Solution to the Critical Section Problem," *Proceedings of ICPP*, August 1994, St. Charles, Illinois, pp. 77-80.

In a Distributed system of  $N$  sites an efficient solution to the critical section problem is proposed to allow multiple simultaneous entries to the Critical Section. The proposed solution is token-based, deadlock-free and free from starvation. In all cases except during the book keeping cycle of the algorithm, the number of message exchanges per Critical Section execution is less than or equal to 5. Only during the book keeping cycle which is not done very often the number of message exchanges per Critical Section execution reaches to at most  $N$ .

PEREZ, Manuel A., Visiting Professor, "Conversational Dialogue in Graphical User Interfaces," *ACM Press*, HCI Conference Companion, May 1995.

Human conversations have long been considered as a Model for interaction with computers. One theory of human conversations, proposed by Clark and Schaefer, has already been used in other HCI efforts. In the presentation, another part of this theory, the states of understanding principles, is discussed as the basis for a

model of feedback for graphical interaction techniques. A formal evaluation of the feedback model, currently being conducted, will be discussed. The feedback model is extended to a multi-threaded dialogue model with which to handle interruption and cancellation requests as negotiated requests. The proposed dialogue model serves as the requirement specification for the design of a dialogue controller in a user interface management system.

PHILLIPS, Andrew T., Associate Professor, co-author, "A Computational Comparison of Two Methods for Constrained Global Optimization," *Journal of Global Optimization*, 1994, 5:325-332.

For constrained concave global minimization problems, two very different solution techniques have been investigated. The first such method is a stochastic multistart approach which typically finds, with high probability, all local minima for the problem. The second method is deterministic and guarantees a global minimum solution to within any user specified tolerance. It is the purpose of this paper to make a careful comparison of these two methods on a range of test problems, and to investigate in this way the advantages and disadvantages of each method. A direct computational comparison, on the same set of over 140 problems, is presented.

PHILLIPS, Andrew T., Associate Professor, co-author, "Molecular Structure Determination by Convex Global Underestimation of Local Energy Minima," *Dimacs Series in Discrete Mathematics and Theoretical Computer Science* 23, 1995, pp. 181-198.

The determination of a stable molecular structure can often be formulated in terms of calculating the global (or approximate global) minimum of a potential energy function. Computing the global minimum of this function is very difficult because it typically has a very large number of local minima which may grow exponentially with molecule size. The optimization method presented involves collecting a large number of conformers, each attained by finding a local minimum of the potential energy function from a random starting point. The information from these conformers is then used to form a convex quadratic global underestimating function for the potential energy of all known conformers. The minimum of this underestimator is used to predict the global minimum for the function, allowing a localized conformer search to be performed based on the predicted minimum. The new set of conformers generated by the localized search can serve as the basis for another quadratic underestimation step. After several repetitions, the global minimum can be found with reasonable assurance. The conformer which lies at the global minimum represents the three-

dimensional folded state of the 1 molecule.

SCHULZE, Kay G., Associate Professor, "An Analysis of Communication and the Use of Military Terms in Navy Team Training," *Journal of Military Psychology* 7(2), April 1995, pp. 95-107.

Efficient communication is essential to effective team coordination. In particular, the use of specialized military terms with specific meanings is essential to accurate communications and also helps keep messages short. Internal Combat Information Center (CIC) communications were recorded during Navy team training. Communication behavior was classified by speech turns, with emphasis on the use of military terms. Even though the purpose of military terms is to promote brevity and accuracy, speech turns with military terms were wordier and had more format violations than those without military terms. Military terms were used as officially defined only 57% of the time, and little change was found over training. Subjective comments made during debrief sessions did not reflect actual measured behavior. The results suggest areas of communication behavior where specific training might be useful, including the accurate use of military terms.

WATT, Anne E., LT, USN, "Modeling of Real-Time Dynamic Effects," *Master's Thesis*, Naval Postgraduate School, Monterey, California, September 1994.

Distributed three dimensional combat simulation systems such as the Naval Postgraduate School's network (NPSNET) project lack many of the characteristic effects of the live battlefield. This deficiency is the problem we sought to eliminate. Our approach to solving this absence of effects was to evaluate previous work performed in this area and incorporate aspects of this research that would assist in creating believable effects capable of running in real-time.

This thesis focuses on simulating three elements of these war zones - realistic clouds both from an internal and external viewpoint which move due to gridded wind vectors, incorporation of a recording and transmission process for dynamic terrain effects through the implementation of the Distributed Interactive Simulation (DIS) protocol's recently approved Destructible Entity protocol data units (PDUs), and physically-based explosions. The result of this research is a set of effects' simulators available for further studying of an experimenting with modifications to these implementations. These programs also provide users with frame rate feedback regarding their modifications to the effects. Furthermore, the cloud implementations and explosive effects are too



computationally expensive to be incorporated within complex simulators such as NPSNET.

WILLIAMS, Leroy George, CDR, USN, "An Experiment Testing Hypertext as a Method of Memory Stimulation," *Ph.D Thesis*, George Mason University, Fairfax, Virginia, May 1995.

In the information age, people are being overwhelmed with the sheer amount of information they are expected to be familiar with. There is just too much information being stored, and not enough time or support to retrieve it, let alone understand it.

Most humans think and remember non-sequentially. Thoughts are stored by association. It would be extremely beneficial to develop a method that helped people forget less, or recall more. A retrieval system based upon associations would be more intuitive, and hence, easier to use. It should foster learning and cognition, not impede it. Hypertext is just such a system.

This paper discusses a series of tests designed to show that the use of a hypertext trail, built during an initial search of a highly technical document, will result in

better recall and cognition during a subsequent review of the same document. Searching a hypertext document results in a trail, unique to that individual and that particular search, indicating which nodes the user has visited. The trail could be used later to provide prompts and cues to help recall information that might otherwise have been forgotten.

The experiment included a test group, which developed and used a hypertext trail, and four control groups using more conventional methods. Subjects answered a set of questions by searching through an on-line tech manual. Following a three month period, subjects reviewed the same document briefly, then answered the same questions from memory. Fifty-two subjects were tested. The hypothesis was not supported. There was no significant difference between any of the five groups. While the hypothesis remains attractive, it appears that in order to make the trail effective, some restrictions are required during the initial search, where memories are

built, and during the subsequent review period, where more precise and directed prompting is required.

## Presentations

BONSIGNORE, Joseph, Maj. USMC, "Emerging Computer Hardware Technology," Top Sail Conference, United States Naval Academy, March, 1995.

HARRISON, Patrick R., Professor, "Advances in CaseBased Reasoning," Navy Center for Applied Research In Artificial Intelligence, NRL, Summer, 1994.

HARRISON, Patrick R., Professor, "Case-Based Reasoning," Computer Science Department Research Seminar, Spring, 1995.

PARK, E.K., Assoc Prof., "Automatic Detection of Errors in Distributed Systems," ACM Computer Science Conference (ACM/CSC95), Nashville, Tennessee, February 26-27, 1995.

PARK, E.K., Assoc Prof., "Intelligent Query Answering in Deductive and Object-Oriented Databases," ACM Conference on Information and Knowledge Management (ACM/CIKM94), at NIST, Gaithersburg, Maryland, 29 Nov-2 Dec, 1994.

PARK, E.K., Assoc Prof., "Towards a Framework for Integrating Multilevel Secure Models and Temporal Data Models," ACM Conference on Information and

Knowledge Management (ACM/CIK94), at NIST, Gaithersburg, Maryland, 29 Nov-2 Dec, 1994.

PEREZ, Manuel A., Visiting Prof., "The Development of GW-Ada," 13th Annual National Conference on Ada Technology, King of Prussia, Pennsylvania, 14 Mar 1995.

PEREZ, Manuel A., Visiting Prof., "Human-Computer Dialog in a Graphical User Interface," USNA, Computer Science Department Research Seminar Series, Annapolis, Maryland, 28 Apr 1995.

PEREZ, Manuel A., Visiting Prof., "Conversational Dialogues in Graphical User Interfaces," CHI95 Doctoral Consortium, Denver, Colorado, 7 May 1995.

PHILLIPS, Andrew T., Assoc Prof, "New Computational Results for the Global Minimization of Indefinite Functions," state of the Art in Global Optimization: Computational Methods and publications, Princeton University, Princeton University, Princeton, New Jersey, 29 Apr 1995.

PHILLIPS, Andrew T., Assoc Prof, "Molecular Structure Determination by Convex Global Underestimation of Local Energy Minima," DIMACS Workshop Global Minimization of Nonconvex Energy

Functions: Molecular Conformation and Protein Folding, Rutgers University, New Brunswick, New Jersey, 20 Mar 1995.

PHILLIPS, Andrew T., Assoc Prof, "Molecular Structure Determination by Convex Global Underestimation of Local Energy Minima." The 15th International Symposium on Mathematical Programming, University of Michigan, Ann Arbor, Michigan, 12 Aug 1994.

PHILLIPS, Andrew T., Assoc Prof, "Molecular Structure Determination by Convex Global Underestimation of Local Energy Minima." SIAM Conference on Optimization, San Diego, California, 16 July, 1994.

SCHULZE, Kay G., Assoc Prof, "Communications in a Distributed CIC Context," Artificial Intelligence Center, Naval Research Laboratory, Washington, DC, Aug. 1994.

SCHULZE, Kay G., Assoc Prof, "Communications in a Distributed CIC Context," Computer Science Department Seminar, USNA, Annapolis, Maryland, Sept. 1994.

SCHULZE, Kay G., Assoc Prof, "Ethical and Professional Issues in Computing," 8th Annual Southeastern Small College Computing Conference, Greenville, South Carolina, 11-12 Nov 1994.

SCHULZE, Kay G., Assoc Prof, "Ethical and Professional Issues in Computing," 26th IGCSE Technical Symposium on Computer Science Education, Nashville, Tennessee, 2-4 Mar 1995.

SCHULZE, Kay G., Assoc Prof, "Baccalaureate Computer Science Programs and Accreditation," Invited Presentation for Region VIII NAFSA-Embassy Dialogue Workshop, George Washington University, Washington, DC, 18 Apr 1995.

WATT, Anne E., LT, USN, "A Modeling of Real-Time Dynamic Effects," Master's Thesis, Naval Postgraduate School, Monterey, California, September 1994.

WILLIAMS, Leroy G., CDR, USN, "An Experiment Testing Hypertext as a Method of Memory Stimulation," George Mason University, Fairfax, VA. May, 1995.

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# Mathematics

Professor Michael W. Chamberlain  
Chair

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Mathematics provides a logical framework and a language indispensable to understanding the technical world in which we live. The following description summarizes the many contributions to this field of study made during the past year by the faculty and midshipmen of the U.S. Naval Academy (USNA). The results cited reveal the great scope, diversity, and applicability of mathematics and offer glimpses of its intellectual beauty and appeal.

Several midshipmen conducted research projects either as Honors Mathematics Majors or in specially created projects under the guidance of faculty members. For example, Professor Peter Turner guided the work of Midshipmen W. Hildebrandt and M. Lambert in "Parallel Numerical Integration and Wavelet Transforms" using the Mathematics Department's new DEC/Maspar parallel computer. Midshipman R. Johns helped Professor Peter Andre investigate a problem of SSBN fleet vulnerability to tagging operations. Professor Reza Malek-Madani worked with the faculty of the Oceanography Department and three of their majors to develop oceanographic-mathematical topics which they presented to the 75th meeting of the American Meteorological Society. And Major P. Long, United States Marine Corps (USMC), with Professor T. Sanders guided Midshipman M. Hines through her Marine Corps sponsored analysis of a Marine Corps transportation problem.

Once again, the USNA Mathematics Department produced a wide range of scholarly work that appeared as technical reports or as publications in refereed journals throughout the world. Over thirty articles appeared as applications of mathematics or as pure mathematical research. Topics included: modeling heart arrhythmias, underwater acoustics

models, fingerprint identification, mathematical physics and cosmology, robotic vision, investigations of elasticity, ship berthing, radar beam-forming, and work in areas such as algebra, harmonic functions,  $C^*$ -algebras, and number theory.

In addition to several independent research projects, over two dozen research projects were sponsored by a variety of sources, such as:

The Johns Hopkins University, Applied Physics Lab  
Office of Naval Research  
Naval Air Warfare Center  
Naval Surface Warfare Center  
Naval Academy Research Council  
NASA, Langley Research Center  
National Science Foundation  
Naval Research Laboratory  
National Security Agency  
National Institutes of Technology  
Cray Research

During the past year, members of the USNA Mathematics Department presented the results of their work on nearly fifty occasions at professional mathematical meetings and colloquia throughout the United States and abroad. This activity, along with publication, enhances the academic stature of the Naval Academy and promotes the professional growth and reputation of those individuals involved. Through research activity, the faculty learn, grow, and stay vital in their discipline. They contribute to the discovery of new mathematics. And they develop new materials and ideas that they can share with midshipmen students in their mathematics courses and projects.

# Sponsored Research

## The Vulnerability of SSBN Fleet to Tagging Operations

Researcher: Professor Peter P. Andre

Sponsor: The Johns Hopkins University, Applied Physics Laboratory

This project studied the effect in the decrease in the size of the SSBN fleet on the vulnerability of the fleet to potential tagging operations by an enemy. Tagging is the clandestine attachment of a device which could at some future time aid in the localization and destruction of an SSBN. If the enemy planned an ASW surge at some future time, he could begin attaching tags to all outgoing SSBN in the hopes of being able to compromise the missions of those SSBNs at the time of the surge. This project built a probabilistic model which describes the number of untagged boats at sea at the ASW surge. The enemy wishes to minimize the

number of such boats by picking as large a tagging interval as possible but selecting one which does not create too great a risk that the tagging operation will be discovered. The U.S. must plan a sufficiently varied tour length schedule for its SSBN so that a tagging operation can be uncovered by the early return of some of its boats. The model handles this two person game and for each distribution of SSBN tour lengths it gives the expected number of untagged boats at sea at the time of the ASW surge. The model predicts that the effectiveness of a tagging operation does improve if the fleet size decreases.

## Poroelastic Models for the Seabed

Researcher: Professor James L. Buchanan

Sponsor: Naval Academy Research Council (ONR)

One of the pressing problems in underwater acoustics today is formulating and then solving a model for interaction of acoustic waves in a shallow ocean with the seabed. A major thrust encouraging this research is the need to investigate inhomogeneities in the seabed, which might result from man-made objects buried in the seabed, submerged wreckage, or mineral deposits. Such investigations give rise to a class of problems known as inverse problems. Gilbert and Xu have investigated inverse problems in a finite depth ocean with a reflecting seabed and reported the results in a sequence of papers. The methodology used in these papers was first to obtain an operator which produced the far field from an incident ray scattered off the target. Then the inverse problem was formulated as an extremal problem. Such an approach could be applied to an ocean seabed model of the Biot type once a suitable fundamental singular solution is available. Moreover, the formulation of the inverse problem as an extremal problem and the corresponding existence theory for solutions should be similar to the reflecting

seabed case. In order to test an algorithm for determining the shape of an inclusion, one needs to compute the far field using a different numerical procedure than is used to invert the far field and determine the shape of the object. With this in mind a method for generating far fields is necessary. These far fields and the method of Herglotz generating functions could be used to reconstruct the object as in the case of the reflecting bottom. Currently the problem of calculating the near and far fields arising from a point source is being considered. Starting with Biot's model for a poroelastic sediment a set of differential equations for the dilatations and vertical displacements in the porous skeleton and the pore fluid is derived. Then a Green's function for the pressure field in the ocean is developed for the case of an ocean over a poroelastic half space with constant Biot parameters. The far field then can be approximated by a residue expansion. Calculation of the near field pressure requires calculation of integrals along branch cuts, as well as the contribution of the residue expansion.

## **Red-Blue Pursuit**

Researcher: Professor Michael W. Chamberlain  
Sponsor: Naval Air Warfare Center, Warminster, Pennsylvania

The Navy is interested in new "heads-up" information displays for pilots. Although electronic information is available to airborne C3 (E-2,E-3) crews, it is time-consuming to process and transmit manually. In addition, (especially in single seat fighters), a pilot must be made aware of potentially dangerous situations quickly and concisely. Two questions investigated in this project were: "Can a detected craft possibly be a friendly that recently was lost from electronic surveillance?"

The objective of this project with the Naval Air Warfare Center Aircraft Division, Warminster, Pennsylvania was to develop and implement a mathematical model that when provided information about friend and foe craft would forecast possible confrontations and how they might develop. Quick mathematical algorithms were developed and coded in Mathematica for initial testing and analysis. Further simulation testing is ongoing.

## **Graph-Matching Neural Networks For Fingerprint Identification**

Researcher: Professor Carol G. Crawford  
Sponsor: Office of Naval Research

This project examines applications of graph theory and neural networks to matching and classification for automated fingerprint identification. In particular, the research centers on the application of generalized sphere-of-influence graphs and other proximity graphs to the design of algorithms for graph-matching neural networks. Metric realization is also explored as

mechanism for developing a classification scheme which would be a natural extension of the matching algorithms. This research project is an outgrowth of a collaborative research effort with Eric Mjolsness, USC, San Diego and Anand Rangarajan, Yale University's Center for Theoretical and Applied Neural Science.

## **Response of Coupled One-Dimensional Dynamical Systems**

Researcher: Prof. James M. D'Archangelo  
Sponsor: Naval Surface Warfare Center, Annapolis, Maryland

Analytic procedures have been developed to investigate the nature of the response of a complex of coupled dynamic systems to an impulse drive. The dynamic systems are one-dimensional and are coupled at junctions. The junctions are characterized by assigning reflection and transmission coefficients at the terminal positions of the dynamic systems. A formal procedure has been developed to obtain an impulse response operator that relates a drive applied to one point in the complex to the response at any other point in the

complex.

The objective is to develop the above-mentioned analytic formal procedure into efficient computer code to assess the practicality of this procedure for predicting the response of complicated dynamical systems.

Computer code has been written using PASCAL on a PC. The code is being rewritten in MPFortran for a massively parallel computer in order to increase the size of the solvable problems.

## **Closed-Loop Degaussing Using Moment Correlation**

Researcher: Associate Professor Gary O. Fowler  
Sponsor: Naval Surface Warfare Center, Annapolis, Maryland

While the details are classified, the goal of the current research is to compare results obtained from a physical model and a real vessel. In particular, can the

conclusions reported regarding the degaussing of a physical model be extended to the problem of degaussing an actual naval vessel.

## Analysis, Convergence and Implementation Using Adaptive Methods to Solve Evolution Systems -such as Anti-Plane Shear Problem

Researcher: Associate Professor Sonia Maria Fidelis Garcia  
Sponsor: Office of Naval Research

The purpose of this proposal is to advance the work that has been done in the last few years under ONR support in the analysis and convergence of numerical schemes for an anti-plane shear problem.

The main objective of our analysis has been to construct schemes to monitor the growth of temperature at the tip of the crack in problem modeling the formation of wing cracks in ice and steel.

During such a study the author realized that many other real problems share the same characteristics, i.e., the numerical solution of nonlinear partial differential equations is often complicated by large local gradients in the solution that evolve in time. These gradients can also occur for example, in boundary layers, shock waves or combustion fronts. As these gradients pass over a mesh point, the solution at that mesh point changes rapidly. When this happens,

small time steps should be taken at these mesh points to accurately integrate the solution while elsewhere larger time steps would suffice. Thus a moving front can result in a multi system of differential equations at the mesh points and force a global small time step. If the mesh points are moved so the solution at the mesh points changes slowly, then the same larger time step may be appropriate everywhere [HY].

Because of that in this proposal the author is initiating a new direction of application and construction of adaptive mesh methods and essentially codes of numerical approximations to evolutionary and steady-state systems of partial differential equations, in particular to anti-plane shear problem. The author will research several strategies on how to best move the mesh points to define a reference frame where the solution is slowly varying.

## Vanishing Theorems for L2-Cohomology of Modified Saper Metrics

Researcher: Associate Professor Caroline G. Grant,  
Sponsor: Naval Academy Research Council

This project was a continuation of earlier work funded by the Naval Academy Research Council (NARC), involving the geometry of complex algebraic varieties. The author, in joint work with Prof. P. Milman of the University of Toronto, has proved that modified Saper metrics satisfy a boundedness criterion of Ohsawa, which is a step toward establishing the vanishing of certain local L2-cohomology groups. These vanishing theorems, in turn, appear to be the key to proving a

major conjecture in this field - that the intersection cohomology of a singular complex algebraic variety is isomorphic to its L2-cohomology with respect to certain complete Kahler metrics. The author and P. Milman have proved the boundedness criterion by two methods, the first primarily algebraic and the second more geometric. A paper on their results is in preparation.

## Nonstandard Analysis and Generalized Functions

Researcher: Professor Robert A. Herrmann  
Sponsor: National Aeronautics and Space Administration, Langley Research Center

This research is concerned with establishing the most significant aspects of the theory of distributions or generalized functions from the nonstandard viewpoint. As usual, one considers a set  $D$  of real valued functions infinitely differentiable on the reals and each member of  $D$  has compact support. Although linear functionals defined on  $D$  are usually defined by the Lebesgue integral and such concepts as the Dirac functional may not correspond to a standard function, one of the more significant results is that for any linear functional on  $D$

, there exists a hyper-polynomial  $p$  such that the linear functional is produced by taking the standard part of the hyper-Riemann integration of product of the  $p$  with each member of  $D$ . This shows that although there does not exist a standard function that shields the Dirac linear functional by this process, there does exist an internal nonstandard function, indeed a hyper-polynomial, that yields this important linear functional. The Schwarz generalized function is studied from the nonstandard viewpoint as it pertains to the pseudo-

metric topological space that yields the required convergence structure. This allows for consideration of S-continuous functions and leads to strong

characterizations for the sums and products, when they exist, of generalized functions.

## Stability of Spacetimes with Mild Singularities or Cauchy Horizons

Researcher: Associate Professor Deborah A. Konkowski

Sponsor: National Science Foundation

The researcher is studying mild singularities and Cauchy horizons in spacetime models. Mild singularities include quasi regular and nonscalar curvature singularities. In the former, particle paths may end with no accompanying physical catastrophes, while in the latter, some particles moving near the singularity will feel infinite tidal forces, not all do. In most cases the spacetime models examined satisfy Einstein's equations.

In particular, the researcher is using a conjecture proposed in her thesis and published with T. M. Hellewell in 1985 to predict whether various mild singularities and cauchy horizons are stable. Thus far the conjecture has held true for the quasi regular singularities in Taub-NUT-type cosmologies and in Khan-Penrose spacetime when fields are added. When applied to the quasi regular singularity in Bell-Szekeres spacetime, and the nonscalar curvature singularity and cauchy horizon in a type V LRS spacetime a prediction was possible but no exact spacetimes were available for comparison. A study of the Cauchy horizons in the Reissner-Nordstrom spacetime using the conjecture accurately predicted the effects of null dust when

compared with exact solutions. The Cauchy horizons in the Kerr spacetime were predicted to be generally unstable to the addition of null dust but no exact solutions were known for comparison.

This year we continued testing Cauchy horizon stability. We used the Cauchy horizons in anti-deSitter and null dust. For the first time the conjecture failed - it predicted correctly the occurrence of a singularity but not the type. We postulated that the problem lay with the Weyl portion of the curvature. We have altered, therefore, the conjecture to correctly predict the singularity type. Further studies using this new, improved conjecture are planned.

Somewhat tangentially, work was also done to understand the nature and stability of the singularity in a Gersch spacetime with complete geodesics but an incomplete time like path of bounded acceleration. The singularity was found to be quasi regular and the spacetime (at least portions of the spacetime) was found to be unstable to the formation of a shell-focusing singularity. Further research is underway with a related spacetime discovered by Tod in 1944.

## OCS Pre-Course Survey Analysis

Researcher: Major Peter F. Long, USMC

Sponsor: S&A MCCDC

OCS candidates are administered a pre-course survey upon reporting on board. Can a candidate performance

be (grad/non grad) predicted solely on the result of the survey?

## Stability, Bifurcation and Fracture in Continuum Mechanics

Researcher: Professor Reza Malek-Madani

Sponsor: Office of Naval Research

This work consists of two specific thrusts. In one the main objective is to develop mathematical tools for understanding when and how thermal effects are the primary factors that destabilize the evolution of classical (i.e., smooth) solutions of the governing equations in continuum mechanics. This research has been strongly influenced by several experimental

works supported by the Mechanics and the Arctic Divisions of ONR which have pointed out, in a rather fundamental way, how thermal effects are at the heart of formation of shear bands in high-strength steel and in elasto-hydro-dynamics (EHD), as well as the important role they play in the formation of wing cracks in ice. In the second thrust I will continue my

work on the analysis of shock capturing for a model of an incompressible liquid in which nondiffusing gas is embedded. This model is motivated by the need to understand formation of voids in lubrication, and is the simplest nonlinear model whose understanding will

have immediate bearing on the theory of continua with voids in general. The mathematical construct that leads to the statement of the governing equations in this model follows from the general framework of continua with microstructure.

## **Fractal Structure of Radar Sea and Rain Scatter**

Researcher: Professor Mark D. Meyerson  
Sponsor: Naval Research Laboratory

Methods will be considered for predicting future data based on time series data. Test data will come from both an accurate computation of a solution to the

Lorenz equations and from real radar data provided by Naval Research Laboratory (NRL).

## **Graphs and Matrices**

Researcher: Associate Professor T. S. Michael  
Sponsor: Naval Academy Research Council

The objectives of this research were to develop a theory for sphere of influence graphs, study algebraic properties Laplacians of tournament matrices, investigate the fundamental matrix equation that arises in a combinatorial inequality, and discover results about domination in strongly regular graphs.

Strong theorems concerning planarity, edge density, and general properties of sphere of influence graphs were established through a combination of geometric and graph theoretic techniques. Laplacians of tournament matrices were investigated largely through a study of algebraic properties of the tournament matrices themselves. Linear algebraic techniques yielded some promising preliminary results about the fundamental matrix equation. Some primitive counting

techniques were applied to the problems in graph domination, but no results were obtained.

The basic theory of sphere of influence graphs has been placed on a firm footing. Many open problems remain, however. The new results on ranks of tournament matrices are of considerable interest in their own right and have already found an application in the theory of block designs. At a conference, the investigator met a Danish researcher who was simultaneously obtaining identical results about the combinatorial matrix equation (in a different guise). Joint work has commenced in this area. There are still no results concerning domination numbers and strongly regular graphs.

## **The Kapur-Saxena-Yang Dixon Resultants**

Researchers: Associate Professor George Nakos, Janet McShane, and Robert Williams  
Sponsor: Naval Academy Research Council (OMN)

Resultants were used during the nineteenth century to solve systems of polynomial equations. Recently, there has been renewed interest in them because fast computers and the availability of symbolic math packages make old and new problems much more tractable. From algebraic geometry to computer graphics there is a substantial need for efficient solutions of systems of polynomial equations.

This research explores a recent work by Kapur, Saxena and Yang, (K-S-Y)<sup>1</sup>, on a generalization of the Dixon Resultant. Our work includes the implementations in Maple and Mathematica of the Kapur-Saxena-Yang algorithms. The programs have been extensively tested and are now available to the Computer Algebra community.

## **A Primer on the Dixon Resultants**

Researchers: Associate Professor George Nakos, Janet McShane, and Robert Williams  
Sponsor: Naval Academy Research Council (OMN)



This work is a primer on the Dixon resultants. We study the classic works of Euler, Bezout, Cayley and Dixon on what is now known as the Dixon resultant and provide many examples that illustrate the old theory and its recent extensions by Kapur, Saxena and Yang.

Recall Cayley's formulation of Bezout's method for solving a system of two polynomial equations. Let  $f(x)$  and  $g(x)$  be polynomials in  $x$ , and let  $a$  be an auxiliary variable. The quantity

$$\delta(x, a) = \frac{1}{x - a} \begin{vmatrix} f(x) & g(x) \\ f(a) & g(a) \end{vmatrix}$$

is a symmetric polynomial in  $x$  and  $a$  which we call the Dixon Polynomial of  $f$  and  $g$ . Every common zero of  $f$  and  $g$  is a zero of  $\delta(x, a)$  for all values of  $a$ . Hence, at a common zero, each coefficient of  $a^i$  in  $\delta(x, a)$  is  $\equiv 0$ . This yields a homogeneous system in variables corresponding to  $x^0, x^1, \dots$ , and equations corresponding to the coefficients of  $a^i$ . This system with coefficient matrix, say  $M$ , has a non-trivial solution if and only if its determinant  $D$  is zero.  $D$  is called the Dixon Resultant of  $f$  and  $g$  and  $M$  is the Dixon Matrix.

The Dixon matrix and a special row echelon form is studied in detail in the primer. In addition, we study the open problem of identifying the extraneous factors in the computation of the resultant by using Dixon's method.

## Projects for Calculus

Researcher: Professor Howard L. Penn

Sponsor: Curriculum Development Program

We develop a series of projects for students taking Calculus. It is planned that there will be four such projects per semester. The projects will have the Midshipmen work in teams on a problem. They will need to use calculators or computer software to solve the problem. Each team will be allowed one week to

complete the project. The report that is generated will be similar to a lab report for Chemistry or Physics. The topics of the projects will be, whenever possible, related to the military. The four projects will together count the same as an hour exam.

## Shifts on Factors

Researcher: Professor Geoffrey L. Price

Sponsor: National Security Agency

One of the key problems in the theory of von Neumann algebras is to study and to classify the position of subfactors of a prescribed index in the hyperfinite  $II_1$  factor. In many ways this problem resembles the analysis of subgroups in group theory: the group-theoretic notions of index, normality, and conjugacy all have analogues in the index theory for subfactors. Over the past few years Price has worked jointly with R.T. Powers to study a family of subfactors in the hyperfinite  $II_1$  factor on which one can define a sort of non-commutative Bernoulli shift of index 2. For each factor in this family there is a corresponding bitstream of 0's and 1's which determines the behavior of the shift. The

structure of the bitstream is reflected in certain properties possessed by the shift. Using computer programs written by the authors to analyze the structure of the bitstreams, the authors have collected evidence suggesting that all binary shifts of commutant index 2 are cocycle conjugate. In joint work with Powers and Erling Stormer, Price has computed the entropy of binary shifts in a number of cases. All binary shifts with finite commutant index have entropy  $\log 2/2$ . There are binary shifts with entropy 0. It is an open question to determine whether there are binary shifts whose entropy takes on intermediate values.

## Endomorphisms of $B(H)$

Researcher: Professor Geoffrey L. Price

Sponsor: National Security Agency

Working jointly with O. Bratteli and P. Jorgensen, Price has studied unital endomorphisms of the algebra of bounded operators on a Hilbert space,  $B(H)$ . The

authors have worked out the structure of a number of classes of endomorphisms in great detail. The main tool in this study is the connection that exists between

shifts and representations of algebras known as Cuntz algebras. Using this tool as well as the classical work of von Neumann on infinite tensor products of Hilbert spaces, the authors have shown that there is a continuum of conjugacy classes of shifts on  $B(H)$ .

Current research is focused on the study of endomorphisms of  $B(H)$  which admit no normal invariant states. These are the most difficult endomorphisms to analyze.

## Isomorphism Invariants for Operator Algebras

Researcher: Professor Geoffrey L. Price

Sponsor: National Security Agency

In general it is difficult to obtain effective invariants to distinguish among isomorphism classes of operator algebras. However, among certain classes of operator algebras one may hope to understand enough about the structure of the algebras in order to determine isomorphism invariants. In joint work with Marcelo Lacas, the author has been studying a class of operator algebras with this goal in mind. The algebras in question are generated by one or more semigroups of

isometric operators on a Hilbert space. This class of algebras includes an important family of algebras which were studied and classified over twenty years ago. Using the complete classification they have obtained of the fixed point algebras of certain gauge group actions on these algebras, the authors hope to show that the number of independent semigroups of isometries needed to construct such algebras is an isomorphism invariant.

## Cruise Missile/TACAIR Effectiveness Assessment Software

Researcher: Professor Thomas J. Sanders

Sponsor: The Johns Hopkins University, Applied Physics Laboratory

This project involved the continued development of a cruise missile and tactical air (TACAIR) effectiveness assessment system that is being done by the Strike and Anti-Surface Warfare Group of the Naval Warfare Analysis Department of the Johns Hopkins University Applied Physics Laboratory (APL). The purpose of this system is to aid an analyst in scenario development, scenario analysis, survivability analysis, mission planning, and equipment performance prediction. During the summer of 1994, this investigator added options and improved the DTED map program (DTMA). Improvements were made to the program's Digital Terrain Elevation Data manipulation capabilities and its radar line-of-sight calculations. New capabilities to generate cruise missile and tactical aircraft routes were also added. This program is expected to become a part of the user interface of the

group's Integrated Air Defense System (IADS) simulation. The DTMA program was written in C++ and MacApp, and may be used by an analyst to display and manipulate Digital Terrain Elevation Data (DTED) files.

The DTED files are data files generated by the Defense Mapping Agency and are used in aspects of cruise missile mission planning. In particular, they are used by an analyst to assist in scenario analysis to investigate such things as radar site location and masking, and cruise missile flight paths. The DTED map program developed allows for computer generated color displays of the (large) data files quickly, and allows the analyst to use the computer to determine radar site locations and masking, and to plan cruise missile flight paths.

## Electromagnetic Signature Reduction

Researchers: Professor John Turner and P. Izat,

Sponsor: Naval Surface Warfare Center, Annapolis, Maryland

Work is continuing on this classified project. Extensive sea trials were conducted in the summer of 1993. Based on analysis of this data, the first stage is considered complete. Work has begun on the next stage of the

project, this involves design of the Mobile Deep Array to gather data from future trials. My work has involved re-analyzing past data to develop better mathematical models, in anticipation of future trials.

## Application of RNS Arithmetic to Adaptive Beamforming

Researcher: Peter R. Turner

Sponsor: Naval Air Warfare Center, Warminster, Pennsylvania

The problem of beamforming is that of tuning an array of antennas so as to maximize the reception in the direction of a desired signal while minimizing the signal strength in the direction of a jammer signal. The antenna array could consist, for example, of radio antennas or sonobuoys. In the situation where the platform carrying the receiving antennas and/ or the transmitting station is moving then the array must be continually retuned and this must be achievable in a very small time-frame. This is known as adaptive beamforming. If the receiving platform is an aircraft or a submarine then space is also at a premium and so the computing devices used must be physically small.

The combined requirements of speed and size imply that conventional computing equipment and standard solution techniques are not suitable. The speed could be achieved with very powerful computers - but not within the physical constraints of an aircraft or submarine. A variety of numerical algorithms have been proposed for the adaptive beamforming problem but again these require modification for the situation envisaged. The problem is therefore to obtain the

appropriate mix of numerical algorithm, arithmetic system and computer architecture to meet these demands.

Residue Number Systems and the associated RNS arithmetic offer the potential for very fast arithmetic since all internal arithmetic is performed on short-word integers. However there are difficulties: the integers are not closed under division or square-root operations, for example. This rules out the use of Gaussian elimination, Cholesky, or QR factorizations and the other standard tools of numerical linear algebra unless the non-RNS operations can be eliminated or at least minimized so as to reduce the cost of conversion between the RNS and other arithmetic systems.

The proposed solution is to modify the Gauss elimination algorithm by eliminating the divisions *entirely*. However the cost of this is rapid growth in the magnitude of the matrix elements as the elimination proceeds. This is in conflict with the restricted dynamic range offered by RNS arithmetic systems. One of the primary achievements this year was the development of an improved RNS division algorithm.

## Implementation and Applications of Level-Index Arithmetic

Researcher: Professor Peter R. Turner

Sponsor: Naval Air Warfare Center, Warminster, Pennsylvania

The proposal was to continue with the development of possible schemes for the eventual hardware implementation of LI arithmetic and the analysis of the algorithms used while at the same time gaining more computational experience and evidence of the potential practical value of the system via applications using software implementations of the level-index, LI and symmetric level-index, SLI arithmetic system. This was a continuation of previous work on the level-index system. This system has the virtues of eliminating overflow and underflow and using a consistent and appropriate measure of precision throughout the range of the real numbers. The advantages are offset by the fact that arithmetic will be slowed down. However the fact that the programmer or software designer would be freed from worries about potential overflow and therefore from the need to scale problems will in many cases more than balance this loss.

The principal objectives were to investigate further the implementation and application of LI and SLI arithmetic and the comparison of these with other proposed new computer arithmetics. The primary goal was to begin the implementation of this system on the

Math Dept MasPar MP-1 system to investigate the advantages to be derived from a massively parallel implementation.

The methods of investigation included mathematical analysis, the development and use of algorithms for various arithmetic systems and their application to the evaluation of mathematical functions. This included a comparative study of the various schemes. The study also included research into recent hardware design developments and their possible use in eventual implementations of the level-index scheme. The other major areas of activity here have been and are concerned with the use of parallel processors and the implications of the parallelism for the arithmetic system used.

The principal output of this research has been in the form of research papers and the development of ideas for publication.

This work is now being incorporated into the broader Computer Arithmetic Laboratory project being pursued jointly with National Institute of Standards and Technology (NIST) and Cray Research, Inc. This project is described separately.

## The MasPar MP-1 as a Computer Arithmetic Laboratory

Researchers: Professor Peter R. Turner, Daniel W Lozier, NIST  
and Michael A. Anuta (Cray Research)

Sponsors: Naval Air Warfare Center, NIST, Cray Research

This project is based on the use of a massively parallel SIMD computer system, specifically the USNA Math dept DEC/MasPar MP-1 system with 4096 processors for the simulation of various forms of computer arithmetic. This architecture has many advantages for such simulations due largely to the simplicity of the individual processors.

Arithmetic operations can be spread across the processor array to simulate a hardware chip. Alternatively they may be performed on individual processors to allow a massively parallel implementation of the underlying arithmetic. compromises between these two approaches permit area-speed trade-offs to be examined.

Extensive experimental testing of the various alternative computer number representation and arithmetic schemes is long overdue and the MasPar will allow this to be done with a reasonably level simulated

playing field. Similarly variations in algorithms for conventional binary integer or floating-point arithmetic can be tested without the need for expensive experimental hardware.

Among the arithmetic schemes which will be (or are being) implemented in the laboratory are the usual binary systems for integer and floating-point arithmetic together with extensions to other word lengths and to fixed point fractional arithmetic. This latter is a necessary component of many of the other arithmetic schemes. Other integer and rational systems will include Residue Number Systems (RNS), and the Lexicographic Continued Fractions (LCD) of Korerup and Matula. For real arithmetic, extended floating-point systems, logarithmic number systems and the level-index (LI) and symmetric level-index (SLI) systems will be added.

## Frequency of Overflow and Underflow Failure in Scientific Computing

Researchers: Professor Peter R. Turner and Alan Feldstein (Arizona State University)

Sponsor: Arizona State University

This work is the continuation of earlier work in which the authors considered this question from the viewpoint of arithmetic overflow resulting from addition and subtraction on the basis of the logarithmic distribution of numbers. The assumption of the logarithmic distribution combined with a further assumption that the distribution of numbers should be smooth and independent of the arithmetic base leads to the claim that the exponents of floating-point numbers should be uniformly distributed. It was on this basis that alarming frequencies of overflow and underflow were obtained. The further observation was made there that these results were unrealistically pessimistic for scientific computing.

This departure from realism was explained by stating that the distribution of exponents is *not* uniform in practical scientific applications because of the choice of units and the scaling of the problem. It is the purpose of this work to examine the distribution of exponents in an attempt to obtain a more realistic model for the occurrence of overflow and underflow failure. Initially, this is applied only to a random process taking no account of the special nature of any particular process.

The basic models used to develop the results are described beginning with a discrete model which is directly comparable to the floating-point situation. This

is followed by a continuous model which can be thought of as modeling the situation which would be encountered in using a logarithmic arithmetic. Such arithmetic systems have been proposed as alternatives to floating-point and extensive work has been carried out in obtaining hardware designs for their implementation. The logarithmic number systems are essentially equivalent to level 1 of the level-index and symmetric level-index systems.

It is shown here that the continuous model mirrors very closely the behavior of the discrete model; a fact which makes it suitable for the analysis of the floating-point situation. This analysis shows that, as the number of multiplicative operations increases, the exponent distribution becomes a spline function of increasing degree which mimics more and more closely a normal distribution function. This remains true until exponent spill begins to take over.

This is followed up by the presentation of computational evidence on the frequency of exponent spill as a result of an extended sequence of multiplications and divisions. One striking aspect is the marked difference between balanced and unbalanced initial ranges of exponents. In the case of even very slight unbalance - which may simply be the result of good scaling applied within an unbalanced floating-

point system - the frequency of exponent spill grows alarmingly. Account is taken here of whether the exponent spill is reported before or after the

normalization of the result.

## Independent Research

### Unique Domino Tilings

Researcher: Professor Craig K. Bailey

A finite simply-connected subboard of the infinite square lattice with a straight bottom can be tiled with dominoes if the number of black squares equals the number of white squares in the standard checkerboard

coloring. Some shapes admit many colorings. This research characterizes those boards which have only one tiling.

### Introduction to Crystal

Researchers: Associate Professor W. David Joyner and R. E. Martin, III

Article for the Maple Technical Newsletter explaining our Maple package in as non-technical a language as possible. The package helps decompose tensor

products of finite dimensional representations of Lie Algebras using Kashiwara's theory of crystal bases.

### An Operator Equation and Relativistic Alterations in the Time for Radioactive Decay

Researcher: Professor Robert A. Herrmann

In this research, using concepts from the nonstandard physical world, the linear effect line element is derived. Previously, this line element was employed to obtain, with the exception of radioactive decay, all of the experimentally verified special theory relativistic alterations in physical measures. This line element is now used to derive, by means of separation of variables, an expression that predicts the same increase in the

decay time for radioactive material as that predicted by the Einstein time dilation assumption. This method does not assume such a time dilation. This indicates that such an increase in lifetime can be attributed to an interaction of the radioactive material with a nonstandard electromagnetic field rather than to a basic time dilation.

### A Hypercontinuous, Hypersmooth Schwarzschild Line Element Transformation

Researcher: Professor Robert A. Herrmann

In this research, a new derivation for one of the black hole line elements is given since the basic derivation for this line element is flawed mathematically. This derivation postulates a transformation procedure that utilizes a transformation function that is modeled by an ideal nonstandard physical world transformation process that yields a connection between an exterior Schwarzschild line element and distinctly different interior line element. The transformation is an ideal transformation in that in the natural world the

transformation is conceived of as occurring at an unknown moment in the evolution of a gravitationally collapsing spherical body with radius greater than but near to the Schwarzschild radius. An ideal transformation models this transformation in a manner independent of the objects standard radius. It yields predicted behavior based upon a Newtonian gravitational field prior to the transformation, predicted behavior after the transformation for a field internal to the Schwarzschild surface and predicted behavior with

respect to field alteration processes during the transformation.

## The Reasonableness of Abrupt Appearance

Researcher: Professor Robert A. Herrmann

This research examines what most scientists consider to be the most fundamental design feature of our universe. This basic aspect is the universe's apparent logical structure. After identifying this logical structure, its relation to humanist, quasi-humanist and strict-theistic philosophies is detailed. This includes an examination of the philosophical foundations for speculative research relative to the scientific origin of our universe. A brief outline of the procedures to used to construct

the MA-model is given. The properties of the MA-model relative to this logical structure and the concept of abrupt appearance are delineated. It is established that the concept of abrupt appearance is a scientific rational concept. It is also shown how these MA-model conclusions uphold the philosophical aspects of strict-theism while its mathematical existence and these conclusions either contradict or falsifies the humanistic and quasi-humanistic belief-systems.

## Restricted Orbit Equivalence for Actions of Discrete Amenable Groups

Researcher: Associate Professor Janet Whalen Kammeyer

The central question in Ergodic Theory is to ask whether two dynamical systems are "the same". For example, suppose  $(X, A, \mu)$  is a Lebesgue probability space. Let  $T$  be a measure preserving, finite entropy, ergodic  $Z$ -action on  $(X, A, \mu)$ . Two such systems are said to be orbit equivalent if there exists a bimeasurable, measure preserving map  $\Phi$  between them which preserves the  $T$ -orbits, as sets. In 1959, H. Dye proved that any two ergodic  $Z$ -actions are "the same", in the sense that they are orbit equivalent.

If more restrictions are placed on this orbit equivalence  $\Phi$ , so that, for instance, the map  $\Phi$  must also preserve the order of the orbits, then any two ergodic  $Z$ -actions which are orbit equivalent in this restricted sense are said to be isomorphic. In 1970, D. Ornstein proved that any two Bernoulli (i.e. independent)  $Z$ -actions of equal entropy are "the same", in the sense that they are isomorphic.

These two notions of "sameness" may be thought of as two ends of a spectrum of restricted orbit equivalence, with orbit equivalence putting essentially no restriction on  $\Phi$  and isomorphism putting a quite rigid restriction on  $\Phi$ . In 1985, D. Rudolph (University of Maryland) published a general theory of restricted orbit equivalence for  $Z$ -actions. He defined the "size"  $m$  of an orbit equivalence, and defined what it meant for two  $Z$ -actions to be "the same", in the sense of being  $m$ -equivalent. He then proved a theorem which gave a

characterization of those  $Z$ -actions which are  $m$ -equivalent.

In 1992, Professor Kammeyer, working jointly with D. Rudolph, developed a notion of restricted orbit equivalence for ergodic actions of the higher dimensional group  $Z^d$ . Currently, Professor Kammeyer, again working jointly with D. Rudolph, is describing restricted orbit equivalence for more general discrete amenable groups. More specifically, we have defined a notion a  $m$ -equivalence for ergodic actions of discrete amenable groups. We have shown that the earlier notions of  $m$ -equivalence for  $Z$ -actions and  $Z^d$ -actions are simply special cases of this more general approach. We have defined a notion of  $m$ -entropy, and shown that each size  $m$  is either entropy preserving (i.e. the  $m$ -entropy is just the regular entropy) or entropy free (i.e. the  $m$ -entropy is zero). We have defined the notion of  $m$ -finitely determined, and have proven that any two  $m$ -finitely determined actions of equal  $m$ -entropy are  $m$ -equivalent. In the process of proving this main result, we have developed several significant and quite general tools, which are basic to the ergodic theory of discrete amenable groups.

This work is nearly complete. Once it has been appropriately polished, it will be submitted for publication, hopefully as a Memoir of the American Mathematical Society.

## Some Examples of Restricted Orbit Equivalence of Discrete Amenable Groups

Researcher: Associate Professor Janet Whalen Kammeyer

For the past several years, Professor Kammeyer (together with colleague D. Rudolph, University of Maryland) has been developing a general theory of

restricted orbit equivalence, as outlined above in the research project entitled, "Restricted Orbit Equivalence for Actions of Discrete Amenable Groups." In

particular, for a discrete amenable group  $G$ , they describe an ergodic  $G$ -action in terms of an "ordering" of  $G$ -orbits. In this way, an orbit equivalence is simply a "reordering" of this described ordering. They define a notion of a size function  $m$ , which, in a sense, measures the amount of distortion that occurs in a reordering. From this, they define a notion of  $m$ -equivalence and prove the basic result:

Any two  $m$ -finitely determined  $G$ -actions of equal  $m$ -entropy are  $m$ -equivalent. There are many such size functions  $m$ . In [KR], Kammeyer and Rudolph define three such size functions (in the case that  $G = \mathbb{Z}^d$ .) For example, they define a size  $m_0$  so that any ergodic process is  $m_0$ -finitely determined, any ergodic process has  $m_0$ -entropy equal to 0 and  $m_0$ -equivalence is exactly orbit equivalence. In particular, for  $m = m_0$  the above theorem is exactly Dye's theorem, that any two ergodic actions are orbit equivalent.

As a second example, again in [KR], Kammeyer and Rudolph define a size  $m_1$  in such a way that the  $m_1$ -finitely determined processes are exactly the Bernoulli processes, the  $m_1$ -entropy of any ergodic process is exactly the usual entropy, and  $m_1$ -equivalence is exactly isomorphism. In particular, for  $m = m_1$  the above theorem is exactly Ornstein's Isomorphism theorem, that any two Bernoulli processes of equal entropy are measurably isomorphic.

Kammeyer and Rudolph outline one other example in [KR], that of even Kakutani equivalence. In each case, these researchers constructed a specific size function  $m$ , then showed that for this, the above  $m$ -equivalence theorem corresponded to a classical

equivalence theorem in ergodic theory. The uniqueness of this Kammeyer/Rudolph point of view is that the  $m$ -equivalence theorem has been proven for general  $m$ . When studying some other notion of equivalence, one need only view it as an orbit equivalence of a certain restricted type, which is somehow described by this size function  $m$ . Theoretically, then, one need only confront two basic issues: (1) What function  $m$  will produce the kind of equivalence that one is interested in; and (2) Once this  $m$  has been constructed, how does one characterize those  $m$ -finite processes which are  $m$ -finitely determined.

In this light, Professor Kammeyer has started to explore other known kinds of equivalence, planning to describe them as an  $m$ -equivalence. For instance, in [FF], Fieldsteel and Freedman describe two notions of equivalence, "weak  $a$ -equivalence" and "strong  $b$ -equivalence," which are both variants of even Kakutani equivalence. These are interesting for several reasons. First, Fieldsteel and Freedman have shown that, in both cases, each equivalence class must contain a mixing action, and, furthermore, any equivalence class that contains an element of positive entropy, must contain a  $K$ -automorphism. Second, the constructions and proofs in [FF] are carried out in the spirit of orderings and reorderings, in a way similar to the techniques of Kammeyer and Rudolph. In particular, this means that there is a natural candidate for  $m$ . Finally, these examples are interesting because they arise naturally as  $\mathbb{Z}^d$ -actions, for  $d \geq 2$ , whereas the other well-known examples (described above) were 1-dimensional examples, that were extended to higher dimensions.

## Numerical Solution of Integro-Differential Equations Using Z-Transforms

Researcher: Associate Professor Thomas J. Mahar

Integro-Differential equations are discretized using a variant of the mid-point rule.  $Z$ -Transforms are then used to obtain a representation of the solution to the discrete problem as a contour integral in the complex plane. Laplace transforms are used to obtain a representation of the solution to the original, continuous, problem as a contour integral in the complex plane. Both integrals are evaluated using residue methods. The point of interest is whether the solutions obtained are in qualitative agreement -

especially in terms of the location of poles with respect to the imaginary axis. This question is not answered by local error estimates for finite time intervals. The problem as described is too broad to solve, so attention is focused on finding a class of kernels for the integral part of the operator for which direct comparison of the poles can be made. Kernels which are trigonometric polynomials can be handled with standard continuation arguments. Various limiting cases of this class of kernels are under investigation.

## Functions in Generalized Pinchuk Classes

Researcher: Associate Professor E. John Moulis

Let  $N$  be the set of all functions  $f$  analytic in  $|z| < 1$ , having the form

$$f(z) = z + \sum_{n=2}^{\infty} a_n z^n$$

We continue our study of the class  $U_k(\beta, c, \lambda)$  of generalized Pinchuk functions  $f$  in  $N$  which are defined

by

$$\int_0^{2\pi} |Re[e^{i\theta} J_f - \beta \cos \lambda]| d\theta \leq k\pi(1 - \beta) \cos \lambda$$

with  $J_f = 1 - \frac{1}{c} + \frac{z}{c} \frac{f'}{f}$ ,  $z = re^{i\theta}$ ,  $0 \leq r < 1$

,  $c$  a non-zero complex number, and

$$-\frac{\pi}{2} < \lambda < \frac{\pi}{2}, \quad 0 \leq \beta < 1, \quad k \geq 2. \quad \text{When } zf$$

is in  $U_k(\beta, c, \lambda)$ ,  $f$  is said to belong to a generalized Moulis class  $V_k(\beta, c, \lambda)$ , named after this researcher who introduced the basic class  $V_k(0, 0, \lambda)$  in his Ph.D. thesis.

We continue to try to find sharp bounds, in terms of the parameters  $k$ ,  $\beta$ ,  $\lambda$ , and  $c$ , the usual geometric mapping properties of functions in these classes, including distortion and rotation bounds as well as bounds on the series coefficients  $a_n$ .

## The $[2^k]$ -Series Revisited

Researchers: Associate Professor George Nakos and  
David Copeland Johnson

This research started when G. Nakos was visiting the Johns Hopkins University while on sabbatical from the U.S. Naval Academy.

Let BP be the Brown-Peterson spectrum associated with the prime  $p$  and let  $F(x, y)$  be the corresponding formal group law. Iteration of the function  $F(x, \cdot)$ , starting with  $F(x, 0) = x = [1]x$ , yields the  $[p^k]$ -series:

$$[p^k]x = \sum_{i=0}^{\infty} a_{k,s} x^{s+1}, \quad a_{k,s} \in BP_{2s}$$

This is an important but poorly understood power series. It gives the defining relation in the Brown-Peterson cohomology (and dually in homology) of the Lens spaces  $L(p^k)$  and of the corresponding classifying spaces  $BZ/p^k$ .

Johnson obtained some information on  $a_{1,s}$  which was generalized by G. Nakos for  $a_{k,s}$ . Recently, Johnson has, once more, obtained an interesting proposition on the coefficients of  $[2]x$  and  $[3]x$  which was again generalized by Nakos. The joined work consists of a reworking of some of the material of the preprint by Nakos titled "The Short Monomial for the  $[2^k]$ - and  $[3^k]$ -series." We prove that each coefficient of the  $[2^k]$ -series is only a monomial modulo a certain power of the maximal ideal of the coefficient ring BP. The power of the ideal for the  $2s$  depends on  $k$  and on the  $p$ -adic expansion of  $s + 1$ . The resulting paper will appear in the Journal of Pure and Applied Algebra.

## Examples in Number Theory Generated with Mathematica

Researcher: Associate Professor JoAnn S. Turisco

This project is a continuation of the previous work involving the calculation of numerical invariants associated to systems of quadratic forms. In addition, work was done on developing an algorithm for

determining prime numbers in certain algebraic number fields. A considerable amount of time was devoted to acquiring some expertise in programming methods using Mathematica.

## Good Matrices - Integer Matrices Which Preserve Greatest Common Denominator

Researchers: Professor William P. Wardlaw and R. Bruce Richter

Let  $R$  be a commutative ring with identity. When  $x$  is an  $r$ -tuple of elements of  $R$ , we write  $(x)$  to denote the ideal in  $R$  generated by the entries of  $x$ , and we define an  $r$  by  $n$  matrix  $A$  with integer entries to be good if  $(xA) = (x)$  for every  $r$ -tuple  $x$ . We discuss a number of properties of such matrices, some of which are included

in the following theorem:

Let  $A$  be an  $r$  by  $n$  matrix over a principal ideal ring  $R$ . Then the following are equivalent;  $A$  is good, the ideal generated by all  $r$  by  $r$  subdeterminants of  $A$  is  $r$ .  $A$  has a right inverse with entries in  $R$ .  $A$  can be enlarged to an  $n$  by  $n$  matrix over  $R$  having an



inverse with entries in  $R$ .

These results are generalized somewhat to any

commutative ring  $R$  with an identity.

## Another Look at N-Associative Groupoids

Researcher: Professor William P. Wardlaw

A groupoid (a set with a single binary operation)  $G$  is  $n$ -associative if every product of  $n$  factors in  $G$  is independent of the way in which these factors are associated. The author showed in "Finitely Associative Groupoids and Algebras," Houston J. Of Math. Vol. 9 no. 4 (1983) 587-598, that for  $n \geq 3$ ,  $n$ -associativity

implies  $(n + 1)$ -associativity, and investigated the possible cardinalities of strictly  $n$ -associative ( $n$ -associative but not  $(n - 1)$ -associative) groupoids. This work uses a new method to find some cardinalities which could not be determined in the first work.

## Fast Entropy Encoding/Decoding

Researcher: Associate Professor Wm. Douglas Withers

At the beginning of this decade, researchers at IBM developed a group of entropy-encoding algorithms, the Q-coder and its relatives, which yield fast encoding and decoding with near-optimum compression performance. These algorithms, however, are unsuitable for many applications; because they have been patented by IBM and are not available for use unless licensed.

The goal of this project is to develop alternative methods of entropy encoding which provide speed equal or superior to the Q-coders but which can be placed in the public domain. A slightly different set of design constraints has also been adopted; while the Q-coders were designed partly with a view to being embedded in hardware, this project is focussed on optimizing performance in software. The project also aims at asymmetrical performance: many applications for entropy encoding involve encoding a data set once and subsequently decoding it several times; so the goal

is above all to render the decoding operation as fast as possible, while keeping the encoding operation moderately fast.

A suitable family of algorithms has been discovered, and various specific implementations are currently under study. Exact performance depends upon the precise circumstances, but the new algorithms are in the same speed class as the Q-coders; under appropriate conditions the new algorithms can be faster than the Q-coders and provide better compression.

A commercial firm is currently examining the new algorithms for possible incorporation into its own image-compression software. This process of adaptation is likely to engender refinements to the current form of the new algorithms. The algorithms will then be published and made available for unrestricted use.

# Research Course Projects

## A Marine Corps Transportation Problem

Researcher: Midshipman 1/C Megan Kathleen Hines

Advisers: Major Pete F. Long, USMC, and Professor Thomas J. Sanders

Sponsor: Headquarters, U.S. Marine Corps

The study investigated was a Marine Corps transportation problem. The scenario was based on the United States national military strategy of conducting two major regional conflicts simultaneously at opposite sides of the globe. Currently, the Marine Corps has three Maritime Prepositioning Squadrons (MPSRONS). Each MPSRON can carry all the equipment and

supplies, including fuel and water, to support a Marine Corps Expeditionary Brigade for thirty days. This project assumes that two of the MPSRONS are deployed in the Pacific Ocean and involved in a Far East conflict, while the other one is involved in a conflict on the other side of the globe. Each MPSRON needs to return to the United States as quickly as

possible to attain the necessary equipment and supplies to resupply the Marines involved in the conflict before the initial thirty day supply is depleted.

Once the initial set of supplies is unloaded for the troops, it will take approximately ten days for the ships of the MPSRON to make the trip back to the continental United States. Thus, it is critical to get the required supplies to the port of embarkation, Long Beach, California, within the time allowed. The supplies will be transported from five different bases located across the United States by three different modes of transportation. The goal of this project is to minimize the cost involved in transporting the supplies and equipment while meeting the time constraint placed on having the supplies to Long Beach.

The problem was set up as a linear programming (LP) problem. The LP model was formulated by defining all of the parameters that were involved in such an operation. Once the parameters were identified, constraint equations were formulated to ensure the transportation problem met all the requirements. Next, a time constraint was added. This insured that the

transportation of supplies was completed within the time allotted by the Marine Corps and allowed each mode of transportation to be used multiple times. Last, the objective equation was defined. This equation determined the cost of transporting the required supplies by the various modes available and was to be minimized. Due to the scope of the problem, General Algebraic Modeling System (GAMS) software was used to specify the model and solve the transportation problem.

The LP solution, however, contained fractions of modes of transportation, which is not possible in applying the solution. To correct this, the problem was modified to a mixed integer program (MIP) and solved using GAMS so that all values in the solution were integers.

The model developed in this study can be easily modified to reflect the requirements of the Marine Corps should the need arise, and the solution to the resulting problem should be useful to the Marine Corps in providing supplies to its marines in a timely fashion.

## Parallel Numerical Integration and Wavelet Transforms

Researchers: Midshipmen 1/C Wes Hildebrandt,  
and Mike Lambert  
Adviser: Professor Peter R Turner

This project grew out of the work in SM426 Numerical Solution of Differential Equations.

The first objective was to devise good parallel code for using the DEC/MasPar MP-1 system to compute numerical integrals accurately and quickly. This was achieved by first developing good serial code for Romberg integration and then modifying this to take advantage of the parallelism. This in turn requires the spreading of necessary function evaluations across the parallel array and then making efficient use of the built-in recursive doubling reduction schemes for summation.

A related problem is that of computing many integrals of the same function over different intervals. This is a naturally parallel operation and is precisely the problem faced in computing Haar wavelet transforms of continuous functions. By breaking each of the step

functions, or wavelets, into its positive and negative parts and using a suitably modified serial Romberg integration code it was possible to compute 2048 wavelet coefficients by performing 4096 integrals each using a different range simultaneously.

A minor modification of the usual algorithm allows the scaling to be simplified in such a way that the reconstruction of the data function from its wavelet transform is a simple reduction-based addition of the appropriate coefficients. This could all be achieved in approximately 10 seconds including all the input-output phase. Another relatively simple modification to the algorithm which entailed restricting the range of integration reduced this time to approximately 0.02 seconds - representing a saving of about 50,000%.

## Publications

ANDRE, Peter P., Professor, "SSBN Fleet Vulnerability to Tagging", APL Project Report, August 1994.

This paper describes a probabilistic model which analyzes the number of untagged SSBNs at an ASW surge after an enemy has engaged in a tagging

operation. Tagging is the clandestine attachment of a device to an SSBN which will aid in localizing and destroying the SSBN on the date of a future ASW surge by the enemy. The model uses the distribution of tour lengths of the US SSBNs as an input and computes the expected number of untagged boats at sea at the time of the ASW surge. The US wants to maximize this

number. The enemy wants to minimize this number. The paper studies the change in fleet vulnerability to a tagging operation if the fleet is reduced in size.

BAKER, B. Mitchell, Associate Professor and KLINE, R.P., "A Dynamical Systems Approach to Membrane Phenomena Underlying Cardiac Arrhythmias," *International Journal of Bifurcation and Chaos*, Vol. 5, No 1 (1995) 75-88.

A model is constructed for cardiac rhythmic response to stimulation via a family of continuous time dynamical systems. Starting with experimentally observed properties common to the kinetics of both repolarizing membrane currents and cardiac action potential responses to sudden changes in cycle length, extremely elementary dynamical assumptions are made concerning current activation and decay, and repolarization threshold. A two-parameter family of one-dimensional dynamical systems emerges. The resulting systems are analytically tractable in considerable detail generating restitution curves, bifurcation schemes, rhythmic responses and chaotic behavior for a representative cardiac cell. The excellent qualitative and quantitative agreement with experimental data reported for several cardiac preparations is discussed. The two-dimensional analog produces unexpected basin behavior which could be of clinical significance in explaining how a single extra beat or a pause could alter subsequent action potential behavior and cause dispersion of refractoriness across the ventricle increasing the risks for arrhythmias. By having a manageable number of parameters, analytically defined patterns of behavior, and computational ease, this dynamical system has the potential to be used in computer simulations to study the effects of antiarrhythmic drugs on complex two- and three- dimensional reentrant substrates, or used on line by an interactive pacemaker.

BUCHANAN, James L., Professor, "Constitutive Equations for a Hyper membrane Shell". In *Asymptotic theories for plates and shells*. R.P. Gilbert and K. Hackl, Eds. Pitman Research Notes in Mathematics Series 319. Longman Scientific and Technical. Harlow, Essex UK.

Transmission loss in the far field for the Biot sediment model. *Proceedings of the 14th IMACS World Congress on Computational and Applied Mathematics*. W.F. Ames, Ed., Georgia Institute of Technology, Atlanta.

CHAMBERLAIN, Michael W., Professor, and Meyerson, Mark D., Professor, Problem #532 appeared in *College Mathematics Journal*, Vol. 25 #4, September 1994, 334.

CRAWFORD, Carol G., Professor, with Eric Mjolsness, "Graph-Matching Neural Networks for Automated Fingerprint Identification," *Congresses Numerantium*, 104 (1994), pp. 97-102.

This paper presents results of a collaborative research effort in applications of graph theory and neural networks to the design of algorithms for searching and matching fingerprints in a large data base. Specifically, the approach makes essential use of inexact graph-matching formulations and neural networks for handling matching and classification of fingerprints. Given a sparse set of minutiae from a fingerprint image, together with their locations in the plane and other labels such as ridge counts to nearby minutiae, the first goal is to construct a graph-like representation of the minutiae map and then to design matching algorithms which can be implemented as neural networks. A discussion of the fingerprint problem is presented with a major focus on graph representations.

GRANT, Caroline G., Associate Professor and P. Milman, "Metrics for Singular Algebraic Varieties," *Pacific Journal of Mathematics*, 168 (Mar 95), 61-156.

The authors give natural inductive constructions of three types of Kahler metrics on the nonsingular set of any algebraic variety  $X$ . The first metric reflects the algebraic structure of  $X$  but is not complete. The second is complete with Poincare-type growth near the singular locus. The third is complete, with growth intermediate between the first two, and generalizes Saper's metric on varieties with isolated singularities. This metric seems to be a good candidate for extending Saper's theorem on intersection cohomology and  $L^2$ -cohomology of varieties with isolated singularities to a larger class of singular varieties. The authors also show that any incomplete metric of the first type which induces an embedded resolution of the singularities of  $X$ , is naturally associated with a complete Saper metric in a very simple way.

HERRMANN, Robert A., Professor, "Special Relativity and a Nonstandard Substratum," *Speculations in Science and Technology*, 17 (1)(1994), 2-10.

Using properties of the nonstandard physical world, a new fundamental derivation for all of the effects of the Special Theory Relativity is given. This fundamental derivation leads to the basic expressions from which Prokhovnik derives the basic Special Theory transformations. However, the interpretations used in this new derivation are completely distinct from Prokhovnik's. Indeed, this derivation shows that the effects of the Special Theory are manifestations of the interaction between our natural world and a nonstandard electromagnetic substratum. This

derivation also eliminates the controversy associated with any physically unexplained universal time dilation and length contraction as well as the logical error of extrapolating the language of relativity to unrelated physical concepts. In this paper, a simple and unified method is developed that predicts the relativistic alterations of physical measures when the behavior of a natural system is characterized by means of a specific operator equation. Separation of variables is the simple underlying procedure.

HERRMANN, Robert A., Professor, "Incompleteness and man-made machines," *C.R.S. Quarterly*, 31 (1994), 148-152.

In this article, in order to correct a few misconceptions, a simple yet in-depth discussion of the procedures, methods and results associated with Godel type incompleteness theorems is given. In particular, the important concepts of formal and informal reasoning processes are discussed and illustrated. Further, information is compiled from the discipline of Mathematical Logic and elsewhere that gives exceedingly strong evidence that there are human mental processes that cannot be duplicated by a man made machine.

HERRMANN, Robert A., Professor, "Operator Equations, Separation of Variables, and Relativistic Alterations," *International Journal of Mathematics and Mathematical Sciences*, 18 (1)(1995), 59-62.

In this paper, a simple and unified method is developed that predicts the relativistic alterations of physical measures when the behavior of a natural system is characterized by means of a specific operator equation. Separation of variables is the simple underlying procedure.

HOFFMAN, Michael, Associate Professor, "Derivative Polynomials for Tangent and Secant," *American Mathematical Monthly* 102 (1995), 23-30.

Support  $f$  is a function whose derivative is a polynomial function of  $f$ , i.e.  $f'(x) = P(f(x))$  for some polynomial function  $P$ . Then successive differentiation of  $f$  produces a sequence of polynomials, as does differentiation of the 'companion' function  $g$  such that  $g'(x) = f(x)g(x)$ . We develop generating functions for these sequences of polynomials. We then specialize to the case  $f(x) = \tan x$  and  $g(x) = \sec x$ , obtaining a functional equation satisfied by the generating functions, and identities for certain improper integrals and infinite series.

KONKOWSKI, Deborah A., Associate Professor (co-author), "Instabilities of the Cauchy Horizon in Kerr

Black Holes", *Physical Review D*, 50 (July 1994), 841

A previously developed Cauchy horizon stability conjecture is used to investigate the stability of the Cauchy horizon in the Kerr geometry when various fields are introduced. In particular, the effects of an electromagnetic field, in falling null dust, and combined in falling and outgoing null dust are studied. Stability predictions are made and in one case verified. The nature of any resulting singularities is predicted.

KONKOWSKI, Deborah A., Associate Professor, (co-author) "Using the Reissner-Nordstrom Cauchy horizon to test a stability conjecture," *Proceedings of the 5th Canadian Conference on General Relativity and Relativistic Astrophysics* (Singapore: World Scientific, 1994), 127-130.

A stability conjecture previously developed to investigate quasi regular and nonscalar curvature singularities is extended here to cover the stability of Cauchy horizons. In particular, the Reissner-Nordstrom spacetime of charged non-rotating black holes is considered.

MALEK-MADANI, Reza, Professor, "Dynamical Systems and Ocean Dynamics", *Naval Research Review*, vol. XLVII, 2-3, 1995.

This paper summarizes recent advances in the area of dynamical systems and their impact on the mathematical modeling of chaotic transport and mixing in the oceans. It points to the scientific role the Office of Naval Research's Applied Analysis Program plays in formulating a new thrust for interdisciplinary research between the mathematics and ocean dynamics communities.

MALEK-MADANI, Reza, Professor, "Symbolic Manipulators in the Classroom", with Professor D.R. Smith and Commander C.R. Gunderson, *Proceedings of the 75th meeting of the American Meteorological Society, the 4th Symposium on Education*, 34-36, 1995.

This paper outlines the results of a four-year effort between the Departments of Mathematics and Oceanography of the United States Naval Academy to develop an interdisciplinary curriculum for advanced courses in mathematics, ocean dynamics and meteorology.

MALEK-MADANI, Reza, Professor, "Entrainment into Cumulus Clouds", with Midshipman Julis Preyer and Professor D.R. Smith, *Proceedings of the 75th meeting of the American Meteorological Society, the 4th Symposium on Education*, 41-43, 1995.

In this paper we present the solution of a system of differential equations that model the entrainment of cumulus clouds based on a model proposed by H. Stommel and Austin & Fleischer. The nonlinear system is solved on Mathematica and details of the behavior of the temperature of a rising cloud are described in the three cases of a) dry, b) moist with no entrainment, and c) moist with entrainment.

MALEK-MADANI, Reza, Professor, "Wind Driven Circulation", with Midshipman B.M. Strong and Commander C.R. Gunderson, Proceedings of the 75th meeting of the American Meteorological Society, the 4th Symposium on Education, 44-46, 1995.

This paper addresses a fundamental model suggested by H. Stommel for the macroscopic steady-state circulation of the Gulf stream. Using Mathematica we solve a boundary value problem for an elliptic partial differential equation whose solution is the stream function for the Gulf stream. This information is then fed into a nonlinear differential equation solver that allows us to monitor the deformation of a patch of fluid under the action of the stream. Finally we give a detailed description of the vorticity in the stream itself.

MALEK-MADANI, Reza, Professor, "Breaking of Waves and Burgers' Equation", with Midshipman G.A. Garrett, Proceedings of the 75th meeting of the American Meteorological society, the 4th Symposium on Education, 50-53, 1995.

This paper contains the analysis of Burgers' equation on Mathematica. Specifically, it is shown how solutions to the initial value problem are computed when the initial function is increasing, thus leading to rarefaction waves, and when this function is decreasing, so that smooth waves break and shock waves are generated in finite time.

MCCOY, Peter A., Professor, "Interpolation and Approximation of Solutions to a Class of Linear Partial Differential Equations in Several Real Variables," Complex Variables, vol. 26, no. 3 (1994) 213-223

Consider the equation  $\nabla^2 \Psi + A(r^2)X \cdot \nabla \Psi + C(r^2)\psi = 0$  for  $X \in E^3$  whose coefficients are entire functions of the variable  $r = |X|$ . Corresponding to a specified axially symmetric solution  $\Psi$  and set  $C_n$  of  $n + 1$  circles, an axially symmetric solution  $\Lambda_n(x, \rho)$  is found that interpolates to  $\Psi(x, \rho)$  on the  $C_n$  and converges uniformly to  $\Psi(x, \rho)$  on certain axially symmetric domains. An extension is given for a class of solutions with the symmetry requirement relaxed.

MEYERSON, Mark D., Professor, and CHAMBERLAIN, Michael W., Professor, "Problem

Proposal #532", College Mathematics Journal, vol. 25, no. 4, September 1994, 334 .

We show how to maximize the viewing angle of a billboard (a classical problem) with the added wrinkle that it's tilted at an angle.

MEYERSON, Mark D., Professor, "The Math Honors Program at USNA", Mathematics Militarism Bulletin of the Mathematical Sciences Departments of the Federal Service Academies, vol. 5, Issue 3, Fall 1994, 7.

The History and goals of the Math Honors Program at the U.S. Naval Academy.

MICHAEL, T.S., Assistant Professor, (with QUINT, Thomas), "Sphere of influence graphs: A survey," Congr. Numer. 105 (1994), 153-160.

G. Toussaint introduced sphere of influence graphs in the 1980's as a new type of proximity graph in the Euclidean plane in order to model situations in pattern recognition and computer vision. More recently graph theorists have defined sphere of influence graphs in arbitrary metric spaces. We survey the main results and conjectures in this young area and include a complete bibliography.

MICHAEL, T.S., Assistant Professor, (with QUINT, Thomas), "Sphere of influence graphs: edge density and clique size," Math. Comput Model., 20 (1994), 19-24.

Sphere of influence graphs (SIGs) were recently introduced by the computer science community to model situations in robotic vision. They also are being considered for use by the FBI to develop algorithms to match fingerprints. Up until now very little has been discovered about SIGs. By placing our SIGs in an arbitrary metric space, rather than the Euclidean one, we obtain strong theorems that hold in general. We also prove theorems that are valid only in the plane under an arbitrary metric and in  $R^d$  equipped with the  $L_\infty$ -Metric. Our results are substantial improvements over those of previous researchers.

PIERCE, John F., Associate Professor, "Transversely Hemitropic and Transversely Isotropic Stress-Strain Relations: an Algebraic Perspective," Journal of Elasticity, 37, 1995, 243-280.

The sets of polynomial stress-strain relations for elastic points which are transversely homotropic and transversely isotropic are presented as projections of free algebraic modules having 20 and 10 generators, respectively. Complete sets of relations for the projections are presented which allow the sets of interest to be identified as free submodules having 12

and 6 generators, respectively. The results are established using the Cartan decomposition of the representation of the adjoint action of the two-dimensional rotation and orthogonal groups on the space of three-by-three symmetric matrices. The results are compared to known representations for nonlinear transversely isotropic stress-strain relations and for linear transversely Hemitropic and transversely isotropic ones.

THURMAN, Katie P., Lieutenant Commander, "Making Preparations to get Underway for 63rd MORSS in Annapolis," *Phalanx*, vol. 28 No. 1 (March 1995), 16-17.

The MORS 63rd Symposium spotlight on "Joint Analysis for Joint Operations"; the U.S. Naval Academy celebrating 150 years of "leadership, service and knowledge with a vision for the future"; and the "sailing capital of the world," Annapolis, celebrating its tricentennial as Maryland's Capital. What better reasons could you possibly imagine for coming to Annapolis on 6,7,8 June - (o.k., a few other attractions do include: Annapolis City Dock shops and restaurants, fine dining, crab feasts, historic sites, recently renovated and enlarged Annapolis Mall, and Eastern Shore Outlets.)

CDR Denny Baer, USN (NCA) and Professor Charles Mylander (USNA) are arranging transportation and parking facilities; in particular, daily buses between the Pentagon and Annapolis so our D.C. attendees have the option to sit back and relax while en route to the MORS' annual summit. Major Pete Long, USMC (USNA) is actively analyzing security parameters with the assistance of the Marine Corps Barracks, Washington D.C. CDR Ted Mixon, USN (USNA) is brushing up on his protocol to assist with all VIP requirements while LT Kathy Stepien, USN (USNA) assists with the plans for the banquet, luncheons, and refreshments. Capt Mark Gallagher, USAF (OSD/PA&E) is ensuring room assignments and audio/visual requests are optimized.

As you stroll the scenic grounds of the U.S. Naval Academy, known as the Yard, the contrasts in architecture reflect the long and colorful history of the academy. Designated a National Historic Site, the Yard's tree-shaded monuments commemorate the courageous graduates and their contributions to naval history. As the Navy grew over the years, the academy expanded from ten acres to a 338-acre complex, from 50 midshipmen to a brigade of 4,000 midshipmen.

Great moments and heros in American Navy and Marine history are represented throughout the Yard in statues, paintings, ships and artifacts. Be sure to allot time to enjoy several of the Academy's many treasures; the Bancroft hall dormitory complex, Naval Academy Chapel and John Paul Jones Crypt, Nimitz Library with

more tha a half million volumes. Hendrix Oceanography Laboratory, the new Naval Academy's visitors' center. U.S. Naval Academy Store, Preble Hall which houses both the Naval Academy Museum (with spectacular collection of 17th and 18th century ship models) and Naval Institute Bookstore, and the Robert Crown Sailing center to name only a few.

Just outside the academy's walls you will find a majestic town filled with enchantment that showcases history, architecture, culture and preservation. As a Chesapeake Bay seaport renowned for its hospitality, Annapolis offers centuries of colonial tradition mingled with the savor of the sea. Don't miss out on this exciting professional and personal opportunity. The entire MORS symposium team is hard at work confirming hundreds of details that will ensure a rewarding, pleasant, memorable and "shipshape" visit.

TURNER, Peter R., Professor, "Work Out Numerical Analysis," MacMillan, UK, September 1994

This book is a "self-study" guide to numerical analysis for undergraduate students. Its coverage includes all the topics usually found in a first course (either one semester or one year) in scientific computing. Each section begins with a brief summary of the theory and then expands upon this by way of worked examples and exercises. The topics covered include most of the traditional ones and some more modern ones. Chapters are included on Computer arithmetic, Summation of series, Iterative solution of equations, Polynomial equations, Linear equations and the eigenvalue problem, Polynomial and Spline interpolation, Least squares approximation, Numerical Differentiation, Integration, Optimization and the solution of Differential equations.

TURNER, Peter R., Professor and KIRSCH, Barry J. "An Analysis of Gauss Elimination for Adaptive Beamforming," NAWC-AD Tech Rep NAWCADWAR - 95003-4.5, 1995

This paper studies the dynamic range requirements for integer solution of the covariance matrix formulation of the adaptive beamforming problem using Gauss elimination. The precision requirements are also studied to obtain parameterizations of the wordlengths which are required for different scale problems. This begins to address the central question of the feasibility of using RNS arithmetic for this purpose.

TURNER, Peter R., Professor and KIRSCH, Barry J. "Operation complexity for integer or RNS Gaussian elimination," NAWC-AD Tech Rep NAWCADWAR - 95004-4.5, 1995

This report analyses the arithmetic operation

requirements of integer and RNS-integer Gaussian elimination for solving a linear system of equations. The number of divisions is critical to the efficiency of RNS processing. The analysis shows that the number of divisions must be kept to a minimum (without allowing the dynamic range to grow beyond available limits) if the time penalty associated with RNS-to-binary conversion using the Chinese Remainder Theorem is to be kept within practical bounds.

TURNER, Peter R., Professor, "An Improved RNS division Algorithm," Report NAWC ADWAR-95002-4.5, 1995

This paper presents a division algorithm for the Residue Number System which is a modification of, and improvement on, the recent algorithm of Hitz and Kaltofen. The relative cost of the division is substantially reduced rendering RNS division feasible for computations which are not division-intensive such as the solution of a system of linear equations of low dimension. The advantages of this algorithm over the work of Hitz and Kaltofen are derived from the use of the ceiling function rather than the floor function. This leads to a better and simpler convergence criterion and test, and, more importantly, to a simple scheme for accelerating the potentially slow early iterations of the Newton-based algorithm.

TURNER, Peter R., Professor, M. ANUTA, and D. W. LOZIER "The MasPar MP-1 as a Computer Arithmetic Laboratory," Report NISTIR 5569, 1995, NIST, Gaithersburg, MD

This paper describes the use of a massively parallel SIMD computer architecture for the simulation of various forms of computer arithmetic. The particular system used is a DEC/MasPar MP-1 with 4096 processors in a square array. This architecture has many advantages for such simulations due largely to the simplicity of the individual processors. Arithmetic operations can be spread across the processor array to simulate hardware. Alternatively they may be performed on individual processors to allow simulation of a massively parallel implementation of the arithmetic. Compromises between these extremes

permits speed-area trade-offs to be examined. The paper includes a description of the architecture and its features. It then summarizes some of the arithmetic systems which have been, or are to be, implemented. The implementation of the level-index and symmetric level-index, LI and SLI, systems is described in some detail. An extensive bibliography is included.

WARDLAW, William P., Professor, Matrix Representations of Finite Fields, Mathematics Magazine, 67 (October 1994), 289-293.

Most undergraduate texts in abstract algebra show how to represent a finite field  $F_q$  over its prime field  $F_p$  by clearly specifying its additive structure as a vector space or a quotient ring of polynomials over  $F_p$  while leaving the multiplicative structure hard to determine, or they explicitly illustrate the cyclic structure of its multiplicative group without clearly connecting it to the additive structure. In this note we suggest a matrix representation which naturally and simply displays both the multiplicative and the additive structures of the field  $F_q$  (with  $q = p^d$ ) over its prime field  $F_p$ . Although this representation is known, it does not appear to be widely used in abstract algebra texts.

WARDLAW, William P., Professor, Minimum and Characteristic Polynomials of Low Rank Matrices, Mathematics Magazine, 68 (April 1995), 122-127.

Let  $R$  be a commutative ring with identity and let  $A$  be an  $n \times n$  matrix over  $R$  with spanning rank  $\text{sr}(A) = r$ . A simple polynomial identity is used to show that  $A$  satisfies a modified Cayley-Hamilton equation

$$A f_D(A) = 0$$

of degree  $r + 1$ , where  $f_D(x)$  is the characteristic polynomial of a suitably chosen  $r \times r$  matrix  $D$ . Moreover, the characteristic polynomial of  $A$  is

$$f_A(x) = x^{n-r} f_D(x).$$

An algorithm is given for calculating  $D$ , and methods are suggested for finding the minimum polynomial of  $A$  when it exists.

## Presentations

ANDRE, Peter P., Professor, "SSBN Fleet Vulnerability to Tagging," Presentation to Submarine Technology Department, Johns Hopkins Applied Physics Lab. 8 August 1994

BAILEY, Craig K., Professor, "Unique Domino Tiling," Washington and Lee University Mathematics Colloquium, Lexington, VA, 20 October 1994.

BAKER, B. Mitchell, Associate Professor, "A Generic

Family of Excitable Systems: Theorems and Applications, University of Chicago, Chicago, IL, 4 November 1994.

BUCHANAN, James L., Professor, "Transmission Loss Over a One-Layer Seabed assuming the Biot Sediment Model," IMACS World Congress on Computational and Applied Mathematics special session on underwater acoustics, Atlanta, GA, 14 July 1994.

CRAWFORD, Carol G., "Applications of Graph Theory and Neural Networks to Computer Vision," Yale University, Center for Theoretical and Applied Neural Science, 12 August 1994.

D'ARCHANGELO, James M., Professor, "Using MPFortran on a Massively Parallel Computer to Solve a Mechanical Vibration Problem," U.S. Naval Academy, Mathematics Department Parallel Computing Seminar, Annapolis, Maryland, 14 April 1995.

GAGLIONE, Anthony M., Professor, "Every 2-free residually free group is 3-free," SUNY-Albany, New York, 16 October 1994.

GAGLIONE, Anthony M., Professor, "Factoring and Groups," Fairfield University, Fairfield, Connecticut, 5 November 1994.

GAGLIONE, Anthony M., Professor, "Residual Properties of Groups and Rings," Temple University, Philadelphia, PA, 12, 19, 25 April 1995.

GAGLIONE, Anthony M., Professor, "Group, Ring, and Logic Stew with a Pinch of Power Series," City College of New York, New York, 11 May 1995.

GAGLIONE, Anthony M., Professor, "Group, Ring, and Logic Stew with a Pinch of Power Series," Ohio-Dennison Group Theory Conference, Miami University, Oxford, Ohio, 19 May 1995.

GARCIA, Sonia M. F., Associate Professor, "Finite Element Methods and Applications," Chair of session, The 14th World Congress of the International Association for Mathematics and Computers in Simulation (IMACS), Georgia Institute of Technology, Atlanta, Georgia, 10-13 July 1994.

GRANT, Caroline G., Associate Professor, "Geometry of Monoidal Transforms", U.S. Naval Academy, Annapolis, Maryland, 19 April 1995

HERRMANN, Robert A., Professor, "A Solution to the General Grand Unification Problem," Maryland, District of Columbia, Virginia Section of the

Mathematical Association of American Fall Meeting, Western Maryland College, Westminster, Maryland, 12 November 1994.

HOFFMAN, Michael E., Associate Professor, "Algebras of Partitions and Some Noncommutative Analogs," U.S. Naval Academy Mathematics Colloquium, 12 April 1995.

KAMMEYER, Janet Whalen, Associate Professor, "Restricted Orbit Equivalence for Actions of Discrete Amenable Groups," University of Maryland/Penn State Regional Dynamics Conference, College Park, Maryland, 14 March 1995.

KAMMEYER, Janet Whalen, Associate Professor, "An Introduction to Restricted Orbit Equivalence, Part I," University of Maryland Graduate Dynamics Seminar, College Park, Maryland, 11 April 1995.

KAMMEYER, Janet Whalen, Associate Professor, "An Introduction to Restricted Orbit Equivalence, Part II", University of Maryland Graduate Dynamics Seminar, College Park, Maryland, 18 April 1995.

KAPLAN, Harold M., Professor, U.S. Naval Academy, "A Fast Program for Testing Symmetry Around Zero," Mid-Atlantic Regional Probability and Statistics Day, Saturday, October 22, 1994.

KONKOWSKI, Deborah A., Associate Professor, "Stability Tests for Mild Singularities," Marcel Grossmann Meeting, Stanford, California, August 1994.

KONKOWSKI, Deborah A., Associate Professor, "Stability Tests for Mild Singularities and Cauchy Horizons," General Relativity Theory Seminar, University of Maryland, College Park, Maryland, September 1994.

KONKOWSKI, Deborah A., Associate Professor, "A Stability Conjecture for Mild Singularities and Cauchy Horizons," London Relativity Seminar, Queen Mary and Wesfield College, London, United Kingdom, 14 June 1995.

MALEK-MADANI, Reza, Professor, "An energy estimate in thermo-visco-elasticity," PDE seminar, University of Maryland, College Park, Maryland, November 1994, Colloquium, Department of Mathematics, Central Florida University, November 1994, and Colloquium, Department of Mathematics, Rensselaer Polytechnic Institute, March, 1995.

MALEK-MADANI, Reza, Professor, "Engineering Mathematics on Mathematica", The Seventh Annual



International Conference on Technology in Collegiate Mathematics, Orlando, Florida, November, 1994.

MALEK-MADANI, Reza, Professor, "A Mathematica enhanced curriculum for advanced calculus for oceanographers," 75th annual meeting of the American Meteorological Society, January, 1995.

MARUSZEWSKI, Richard F. Jr., Associate Professor, "Using Spreadsheets in a Differential Equations Course," New York State Mathematics Teachers Conference, New York, New York, 1995.

MARUSZEWSKI, Richard F. Jr., Associate Professor, "Introduction to the Mathematics Department Computer Systems," U.S. Naval Academy Mathematics Department Computer Seminar, Annapolis, Maryland, Fall 1994.

MARUSZEWSKI, Richard F. Jr., Associate Professor, "SUN Windowing Systems," U.S. Naval Academy Mathematics Department Computer Seminar, Annapolis, Maryland, Fall 1994.

MCCOY, Peter A., Professor, "Interpolating Scattering Solutions on Multiply Connected Plane Domains," SIAM 42nd annual meeting, San Diego, California, 25 July 1994.

MCCOY, Peter A., Professor, "A System of Hyperbolic PDE's in  $R^3$ ; Singularities and a Classical Theorem on Legendre Series," Mathematics Department Colloquium, U.S. Naval Academy, Annapolis, Maryland, 26 October 1994.

MCCOY, Peter A., Professor, "Approximation of Radiating Solutions of the Helmholtz Equation," Session I on Partial Differential Equations, 101st annual meetings of the American Mathematical Society, San Francisco, California, 5 January 1995.

MCCOY, Peter A., Professor, "Shannon Sampling in the Role of Signal Processing," Wavelets Seminar, Mathematics Department, U.S. Naval Academy, Annapolis, Maryland, 1 March 1995.

MCCOY, Peter A., Professor, "Applications of single processing methods to boundary-initial value problems," invited lecture at the Special Session on Sampling Theory, Wavelets, and Signal Processing, American Mathematical Society meeting #899, Orlando, Florida, 18 March 1995.

MICHAEL, T. S., Assistant Professor, "Tournaments and Matrices," Mathematics Department Colloquium, U.S. Naval Academy, September 1994.

MICHAEL, T. S., Assistant Professor, "Sphere of Influence Graphs," invited address at the Third Workshop on Proximity Graphs, Mississippi State University, December 1995.

MICHAEL, T. S., Assistant Professor, "Tournaments and Ranks," presented at the Combinatorics Seminar at George Washington University, April 1995.

PENN, Howard Lewis, Professor, "A Comparison of Test Scores for Students Taking Reformed and Regular Calculus," Third Annual Conference on the Teaching of Mathematics, Ann Arbor, Maine, July 1994, Invited Talk

PENN, Howard Lewis, Professor, "Fun with Parametric Equations," Mathematical Association of America Summer National Meeting, Minneapolis, Minnesota, August 1994.

PENN, Howard Lewis, Professor, "Calculus Reform-What is it? What's Next?" Panel Discussion, Frostburg State University Mathematics Symposium, Towson, Maryland, April 1995

PIERCE, John F., Associate Professor, "Spontaneous Symmetry-Breaking Bifurcations for Pseudo-Rigid Bodies," Department of Mechanical Engineering, University of Manitoba, Winnipeg, Manitoba, Canada, 14 July 1994.

TURNER, Peter R., Professor, "Adaptive beamforming using RNS arithmetic," Naval Air Warfare Center-AD, November 1994

TURNER, Peter R., Professor, "Dynamic range and precision analysis for adaptive beamforming," SIAM National Meeting, San Diego, CA, July 1994

TURNER, Peter R., Professor, Midn W.A. HILDEBRANDT and Midn M.T. LAMBERT, "Numerical Integration and Computing Wavelet Transforms in Parallel," JSACCIM, West Point, April 1995

TURNER, Peter R., Professor, Daniel W. LOZIER, and Michael A. ANUTA, "The MasPar MP-1 as a Computer Arithmetic Laboratory," ICIAM Hamburg, July 1995

TURNER, Peter R., Professor, Daniel W. LOZIER, and Michael A. ANUTA, "Level-index arithmetic on a massively parallel computer," ICIAM Hamburg, July 1995

TURNER, Peter R., Professor, and Daniel W. LOZIER, "Error-Bounding in Level-Index Computer Arithmetic," International IMACS- GAMM Symposium on Numerical Methods and Error Bounds, Oldenburg Germany, July 1995

WARDLAW, William P., Professor, "Good Matrices - Integer Matrices which Preserve GCD," U.S. Naval Academy Mathematics Department Colloquium, 23 March 1994, and National Meeting of the American Mathematical Society in San Francisco, California, 6 January 1995.

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# Oceanography

Captain C.A. Martinek, USN  
Chair

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**A**cademic year 1994-1995 was very productive in terms of US Naval Academy oceanographic and meteorological research. The Oceanography Department research philosophy is guided by two baseline themes: maximize midshipmen involvement, while, employing "total quality" techniques. The faculty accomplished some very significant successes with respect to these principles.

Twenty students participated in the seventh summer research cruise aboard the Naval Academy's oceanographic platform, YP686. Sixty-one oceanographic stations were completed in this four-week endeavor; physical biological, chemical, meteorological, and geologic data were collected and processed; state-of-the-art equipment and techniques were employed, as were classical but effective methods and tools.

Midshipmen including two Trident Scholars and Honor Students, were involved in direct, "hands-on" research through enrollment in the Department's Independent Research courses. These research projects, directed by both civilian and military faculty, introduced the students to the excitement and responsibility of data collection and analysis. Our midshipmen invariably commented on the invaluable learning experience that this exposure to the scientific method represents for them. During formal presentations of their research, at the end of each

semester, these young investigators came together and shared the results of their efforts and experiences with the Faculty and Senior Administrators. A high point for the year was the second place award received by Midn 1/C Timothy Winter, a Trident Scholar, in the Father James B. Macelwane Undergraduate Research Paper Competition. This is the fourth such award received by Oceanography students since 1990.

As a result of the Department's Independent Research program, five midshipmen went on to deliver oral and poster presentations at professional conferences of the American Geophysical Union, The Oceanography Society and The American Meteorological Society.

The first Maury Project summer workshop was held. This program, sponsored by the National Science Foundation, brought 26 science teachers (K-12) to the Oceanography Department for a two-week long series of classroom and applied sessions. The objective of the program, to be continued until 1996, is to enhance the scientific foundations of the teachers in the area of physical oceanography. The Department's staff, both civilian and military, participated in this project.

Our Faculty continue to be actively involved in scientific and scholarly endeavors, without losing sight of the need to have at their disposal the latest technologically advanced instrumentation and methodology.

## Sponsored Research

### Twilight and the Naked-eye Observer: Models and High-resolution Measurements

Researcher: Visiting Professor Raymond Lee  
Sponsor: National Science Foundation

This research will use twilight's optical structure to evaluate the verisimilitude of atmospheric scattering models. However, unlike other researchers, we propose to do our testing with a remote sensing system that combines multiple spectral channels with broad bandwidths, and very high spatial and temporal

resolutions.

This remote sensing system is human trichromatic color vision, which has the obvious disadvantage that it is essentially subjective. However, trichromatic analogues of color vision, such as color film and digital imaging systems, let us map their

objective and reproducible responses into those of a typical naked-eye observer. Other advantages gained by using photography and digital imaging include the ability to easily analyze the temporal evolution of twilight spectra at very high resolutions, and the spatial details of twilight polarization.

Now we extend our work to no less challenging a remote-sensing problem, the rapidly changing low-light spectra of twilight. Specifically, we plan to use digital image analysis of color slides, occasionally corroborated by spectroradiometry, to explore the photometric, polarimetric, and colorimetric structure of twilight. With a variety of data inversion

techniques, we will then assess how well various atmospheric scattering models account for twilight as seen by the naked-eye observer (we include here observers equipped with simple linear polarizers).

In the past, twilight's ephemeral nature has restricted researchers to gathering only limited amounts of photometric and polarimetric data, and then usually only as a means of constructing atmospheric soundings. Colorimetric studies of twilight are even rarer. As worthwhile as twilight-derived atmospheric soundings are, here we propose a quite different goal namely, measuring and modeling twilight's largely unquantified visual structure.

## **Major Winter Snow Storm Development: A Comparison of Two Case Studies**

Researcher: Midshipmen I/C Brad Artery

Adviser: Professor David Smith

Sponsor: Trident Scholar Program

Major winter storms, characterized by heavy snow or rain, strong winds, and large tidal surges often strike the east coast of the United States. Resulting problems such as power outages, damaged property, and clean-up efforts cost millions of dollars yearly. In addition, vehicle accidents due to icy roads and poor visibility as well as shipping casualties in high seas cost many lives. The large number of factors which can either help or hinder cyclone development and the lack of sufficient ocean-based observations make these storms extremely difficult to predict.

The primary objective of this research is to determine what factors lead to the explosive development of these winter storms. This will be accomplished by comparing two recent East Coast winter storms. The first storm to be investigated is the

"Storm of the Century" which devastated the East Coast from 12-15 March, 1993. Record amounts of snowfall and low pressure readings were set all along the coast. This extremely powerful cyclone will be compared with a less severe storm during the winter of 1993-94. (The actual case will be determined later.)

A number of meteorological variables are examined in order to determine which play a primary role in explosive cyclone development. This data are obtained through conventional observations as well as numerical model output from the National Meteorological Center. By comparing the data, a better understanding of the conditions most favorable to major winter storm development will be reached. This in turn can aid meteorologists in predicting the occurrence of this violent phenomenon.

## **Independent Research**

### **Acoustic Analysis of the Spring Oceanic Zooplankton Community in the Northeastern North Pacific Ocean**

Researcher: Professor John W. Foerster

An intensive short-term study of zooplankton in the northeast North Pacific Ocean occurred during April of 1989. Sampling was one over 330,000 square kilometers down to a depth of 125m. The sampling system used two simultaneously towed devices. One system deployed a dual narrow beam sonar system (38

kH, 2000kH). Another device sampled the oceanographic parameters of conductivity, temperature, depth and chlorophyll a continuously updated satellite navigation positions. Surveys for zooplankton occurred at night for 10-12 hours at speeds between 8-10 knots. Twice daily the ship stopped for vertical stations. The

information collected was for species identification. The purpose of the study was to map an area of the ocean in as synoptic a fashion as possible. The hypothesis tested was that multi-dimensional distribution (patchiness, diffusion, layering) is mapped

adequately by acoustic techniques. Zooplankton data are compared to oceanographic measurements and water masses. Layers are identified with the horizontal and vertical distributions.

## **Analysis of Digital Topography and Bathymetry**

Researcher: Associate Professor Peter L. Guth

A toolbox for the analysis of digital topography and bathymetry is under development. This toolbox, a collection of programs running on MS-DOS microcomputers, allows the manipulation and display of

gridded data sets, and the calculation of various parameters like FFT, semi-variograms, and fractal dimensions. This analysis will help us to better characterize landforms and their development.

## **Development of High-Resolution Monthly Mean MCSST Product**

Researcher: Adjunct Assistant Professor Alan E. Strong

Using weekly average MCSST data derived from NOAA's AVHRR, monthly mean sea surface temperature products are being refined to expand the presently produced 2.5 lat/long spatial resolution to 36km (1/3rd degree lat/long). These higher resolution products permit anomaly imagery to be produced that

retain the monthly and yearly variabilities of most ocean current systems. These features were not resolved with the older monthly mean product. In addition, statistical summaries are being accumulated that portray zonal, regional, and global SST trends during the past 12 years of data taking.

## **A Cooperative Research Program Between the U.S. Naval Academy and the U.S. Environmental Protection Agency**

Researcher: Associate Professor Mario Vieira

The Oceanography Department at the U.S. Naval Academy (USNA) has embarked on a cooperative research program with the US Environmental Protection Agency (USEPA). The objective was to study the oxygen dynamics of the Severn River, a small tributary of the Chesapeake Bay, while providing an opportunity for USNA faculty and student involvement. A mooring was maintained between August and November 1994 near the mouth of the river. The system was equipped with a SeaBird CTD (with added oxygen and PH sensors) and two S-4 InterOcean current meters with conductivity and temperature capability.

It was the first time that a comprehensive set of oceanographic measurements was taken in the Severn River. Midshipmen from the USNA were

involved in the project and are participating in the analysis of the data. A preliminary assessment of the data collected is presented. The Severn River Estuary was determined to be a partially mixed estuary subjected to a classical estuarine circulation. It was classified as a Type 2b estuary according to the Hansen and Rattray criterion.

It is expected that an understanding of the dynamics of the Severn River will allow the development of appropriate management measures by the Environmental Protection Agency.

This joint project constitutes a small scale paradigm of converging interests, inter-agency cooperation and maximizing of resources.

# Research Course Projects

## **Atmospheric Conditions that Contribute to the Development of a Heavy Precipitation Event: A Case Study of the Southeastern U.S. (26-29 March 1994)**

Researcher: Midshipman 1/C Christy J. Goode, USN  
Advisor: Associate Professor David R. Smith

Heavy precipitation poses a concern to public safety, agriculture, and personal property. Even with today's technology these systems, which produce six or more inches of rain, are often incorrectly forecast. The goal of this research was to determine which variables offer the best indication of, and are, therefore, significant forecasting tools for a heavy precipitation event.

The frontal system which passed through the southeastern United States 26-29 March 1994 was examined as a typical heavy precipitation event. Two main sources of information were utilized: National Meteorological Center facsimile products and the PC-GRIDDS software package. It was expected that the following variables played an integral role in the

development of the event: temperature, pressure, vertical velocity, water vapor mixing ratio, mixing ratio advection, moisture flux convergence, and topographical and frontal lifting.

Examination of PC-GRIDDS output confirmed expectations. Changes in temperature and pressure were excellent indicators of the strength and location of fronts and pressure systems. The presence of upward vertical velocity suggested that necessary lifting was present; both frontal and orographic lifting occurred. It is concluded, however, that the most significant atmospheric variables in the forecasting of a heavy precipitation event are mixing ratio advection and positive moisture flux convergence.

## **An Examination of Severe Local Storm Development: Determining Effective Predictive Tools**

Researcher: Midshipman 1/C Amy Hutchison, USN  
Advisor: Associate Professor David R. Smith

Observations of severe weather phenomena lead to the identification of specific characteristics associated with intense storm development. For years, meteorologists have been observing the conditions surrounding severe local storm development and convective deepening with a variety of conventional observational tools. Although these types of observations proved helpful in the detection of storms they are not totally adequate in providing information for timely forecasting of severe storm occurrence. Recent developments by the National Weather Service have resulted in new tools to improve forecasting capability of severe local storms. This study shows the use of two such tools: PC-GRIDDS and Dopplar radar. PC-GRIDDS is an analysis package which utilizes numerical model

forecast data to generate a variety of graphical displays of meteorological fields that provide valuable guidance regarding storm development. Dopplar radar is arguably the most reliable means of detection and nowcasting of severe storm development. It provides reflectivity information and the velocity component toward and away from the radar beam. Further, the system provides high resolution time histories of vertical wind profiles which is useful in detailing the structure of the storm and its environment. Three cases of storms which produced tornados are examined. These cases demonstrate the value of these new technologies in diagnosing potential severe weather situations.

## **A Climatological Study of Cyclone Development Over the East Coast of the United States and the Western Atlantic Ocean**

Researcher: Midshipman 1/C Katie M. Jones, USN  
Advisor: Associate Professor David R. Smith

Extratropical cyclones are winter storms that develop along frontal systems. "Bombs" are an especially intense extratropical cyclone that intensify at an explosive rate of at least 1mb/hr pressure fall over a 24-hr period. These are major weather producers generally developing over a marine environment that can cause extensive damage to coastal areas. For this reason, accurate forecasting techniques are needed to predict these storms. Recent studies have provided more accurate information on the nature of the storms such as the influence of the polar front and the relationship to sea surface temperature gradients.

This project proposes to develop a detailed climatology of explosive cyclogenesis for the years

1980 to 1993 in the area along the North American coast and in the Northwest Atlantic basin. This study will use a CD-ROM dataset to examine the number of cyclones, their intensities, and percentages of those that develop into bombs. The data will be collected over 5 deg square gridboxes, where all the cyclones falling within a block will be counted.

The proposed results from this study will provide maximum and minimum monthly and seasonal frequencies of the bombs for both coastal and oceanic areas. This will suggest when and where these explosive cyclones are most likely to occur, which may provide insight to improving the ability to predict these hazardous marine storms.

## **The Development of an Operational Global Ocean Climatology through the use of Remotely Sensed Sea Surface Temperature**

Researcher: Midshipmen 1/C Timothy M. Winter

Visiting Adviser: Assistant Professor Alan E. Strong and Associate Professor P. L. Guth

Sponsor: Trident Scholar Program

Monthly mean satellite-derived sea surface temperature [SST] data has been derived using daytime and nighttime AVHRR (Advanced Very High Resolution Radiometer) data. This data is collected by the present multi-channel, National Oceanic and Atmospheric Administration (NOAA), polar orbiting satellite. The produced MCSST weekly averages were compared to moored-buoy temperatures in order to validate the satellite data for use. The average error from the individual selected buoy comparisons were found to be under 0.5° C. The monthly daytime and nighttime climatologies were created from 1984-1990 and 1993. The years omitted were discarded due to volcanic

aerosol corruption (El Chichón 1982/83, Mt. Pinatubo 1991/92) and contaminated data. These resulting monthly climatologies provide SST fields at approximately 1/3rd° latitude/longitude resolution. From these 8 year climatology fields, anomaly fields have been created comparing the satellite climatology with the older and coarser-resolution climatology constructed from conventional SST data. Regional and zonal anomalies were also created to highlight the deficiencies, especially in the Southern Hemisphere, in the older climatology resulting from a lack of buoy/ship (*in situ*) data.

## **Severe Coral Reef Bleaching Events of 1994 Related to Sea Surface Temperature**

Researcher: Midshipman 1/C Greg K. Emery

Adviser: A. E. Strong, Visiting Professor

The development of the 1994 coral reef bleaching event during March-April 1994 that effected much of the central tropical Pacific has been dramatically displayed using sea surface temperature [SST] anomaly fields based on AVHRR satellite data. Taking advantage of a new, high-resolution, satellite-only SST climatology, it is now possible to examine events such as high temperature-related bleaching with better definition and accuracy. Many additional anomalous features throughout the tropical Pacific show improved detail when compared to our new climatology that is based on

the 1984-93 period: equatorial long-waves, upwelling events in Gulf of Panama, etc. Another warm water episode in the vicinity of Bermuda appears during June 1994 that is also responsible for bleaching in the reefs around that island. A time-lapse video of weekly SSTs and anomalies for 1994 is included in the presentation. From these data it can be demonstrated that the onset of bleaching begins when SSTs exceed the normal highest monthly value by +1°C. Key buoys [moored] are used to provide verification.

## Publications

FOERSTER, John W. Professor, "Sentinel Species: Biologically Active Trace Metals in the Livers of the Oyster Toadfish (*Opsanus tau*). (with Smart, Correll and Edsall) Proceedings of the Coastal Oceans Conference 5:1993-2008.

Oyster toadfish (*Opsanus tau*) are a resident part of the estuarine benthic food web from the New England States to Florida in the U.S.A. They are a sentinel species with the potential to extract toxic environmental trace metals. To test this hypothesis, we are studying toadfish resident in the Chesapeake Bay near Annapolis, Maryland, U.S.A. This area is away from any direct industrial or commercial effluents carrying trace metals but has concentrations of trace metals in the benthic sediments. Since the toadfish is a resident, non-migratory benthic predator, we feel it is useful in studying trace metal contamination and eventually modeling metal movements in a biological system. Historical information indicates that the dredging patterns associated with the Baltimore, Maryland, Harbor are a potential source of trace metal contamination. This study concentrates on trace metals found in the physiologically important organ, the liver. Our study uses a proton induced x-ray emissions (PIXE) system to analyze for the trace metals. The PIXE system allows us a rapid method to determine trace metal types, concentrations and an archiving method for samples. Present analyses of various size toadfish show that the livers contained concentrations of chromium (5.9-51.7 mg/L), copper (3.3-26.0 mg/L), and zinc (8.6-29.9 mg/L). The trace metal amounts vary as a function of the size, age, and sex of the fish. Copper and chromium concentrations deplete with age after the reproductive phase, while zinc concentrations increase. Generally, the trace metals have an accumulation pattern of chromium>zinc>copper that is different from the zinc>copper>chromium in the sediments of the Atlantic and Gulf coasts of the United States. Thus the life history of the animal appears as an important factor in trace metal accumulation. This leads to postulating a conceptual model for trace metal flow through this biological system. Although establishing that trace metal concentrations appear linked to the life history stage of the toadfish, we plan further work on the impact as well as protective mechanisms.

SMITH, D. R., R. S. Weinbeck, I.W. Geer, J. T. Snow, K. M. Ginger, and J. M. Moran (1995), "1994 Project ATMOSPHERE Summer Programs for Teachers", *Bulletin of the American Meteorological Society*, June

1995.

Project ATMOSPHERE, the K-12 educational program of the American Meteorological Society, has been involved in teacher enhancement for four years. Summer workshops for teachers have been a primary component of the AMS K-12 educational initiatives since its inception. During the summer of 1994, Project ATMOSPHERE conducted four workshops: two of the workshops were for teachers in the Atmospheric Education Resource Agent program, another for K-12 teachers including one teacher each from Canada and Australia, and the fourth for faculty members at community colleges or four-year undergraduate institutions. These workshops provide teachers at all levels with instruction on a variety of atmospheric topics, an introduction to the operational and research activities of the meteorological community, and exposure to atmospheric scientists and their facilities. Such workshops provide enriching experiences for educators who teach about weather and climate topics in their science classrooms.

SMITH, D. R., J. P. Mulvany, W.A. Krayner, M.A. Rosenthal, G. J. Koester, R. L. Lees, J. J. Matkins, B. Smith, W. Sanford, and L. E. Harrell, "AERAs Host Teacher Workshop: Hazardous Weather Conference for Educators", *Bulletin of the American Meteorological Society*, 75(10), June 1994, 1839-1845.

Project ATMOSPHERE AERAs representing the mid-Atlantic states pooled resources to conduct a regional workshop for teachers. This conference used hazardous weather as its central theme. Over 150 attended this one-day event held in Richmond, Virginia, which included three concurrent sessions of eight presentations each. The workshop included presentations by meteorologists and educators from the National Oceanic and Atmospheric Administration, Virginia Power, television stations, as well as the AERAs themselves. The presentations were designed to develop basic understandings about hazardous weather and to provide guidance for establishing hazardous weather emergency action plans for schools. The orientation of the program was hands-on, including a number of activities for teachers to implement in the classroom. This workshop demonstrates how educators and scientists, can form partnerships to improve science education.

SMITH, D. R., L. M. Bastiaans, R.S. Weinbeck, M. J.



Passow, P. J. Smith, N. N. Rydell, H. P. Warthan, T. C. Spangler, A. E. MacDonald, "Meeting Report on the Third AMS Symposium on Education", *Bulletin of the American Meteorological Society*, 75(7), 1994, 1241-1247.

In recognition of the educational efforts throughout the atmospheric and oceanic science communities, the AMS has instituted an annual forum called the Symposium on Education. The third such symposium was held this year in conjunction with the 74th Annual Meeting in Nashville, TN. The theme of this year's Symposium was "Preparing for the 21st Century". Thirty-one oral presentations and 26 poster presentations summarized a variety of educational programs or examined issues of importance for both the precollege and university levels. In addition, there was also a panel discussion on future directions for the undergraduate degree in the atmospheric and marine sciences. One interesting aspect of this year's Symposium was a joint session with the 10th International Conference on Interactive Information and Processing Systems for Meteorology, Oceanography, and Hydrology on new technologies for the classroom. Over 200 people representing a wide spectrum of the Society attended one or more of the sessions in this two-day conference, where they increased their awareness of educational initiatives of members and institutions associated with AMS.

GEER, I. W., D. R. Smith, R. S. Weinbeck and J.T. Snow, "Project ATMOSPHERE: AMS precollege educational initiative - An overview of progress", *Preprints of the 4th AMS Symposium on Education*, Amer. Meteor. Soc., Boston, MA, 1995, (J1)10-12.

Project ATMOSPHERE is in its fourth year of operation with a national network of Atmospheric Education Resource Agents (AERAs) nearing full implementation. Instructional resource materials have been developed. AERAs are providing leadership at state, regional and national levels to promote studies of the atmospheric environment across the K-12 curriculum. This program is directed towards encouraging investigations of the atmospheric environment to generate interest in science, mathematics, and technology among young people. A overview of activities during the past year will be presented.

SMITH, D. R., P.L. Guth, M.E.C. Vieira, D.W. Jones, J.F.H. Atangan, D.S. Dillner, C.A. Martinek, A.E. Strong, E.J. Miller, R.D. Middleton and G.A. Eisman, "The Maury Project: A teacher enhancement program in physical oceanography", *Preprints of the 4th AMS Symposium on Education*, Amer. Meteor. Soc., Boston,

MA, 1995, (J1)13-16.

The American Meteorological Society (AMS), in partnership with the U.S. Naval Academy, assisted by the National Oceanic and Atmospheric Administration and the State University of New York at Brockport, are conducting a four-year national teacher enhancement project. This NSF-funded program, called the Maury Project, will focus on the physical foundations of oceanography. The central component of the Maury Project is a series of two-week workshops conducted at the U.S. Naval Academy to train 72 master precollege teachers in selected physical oceanography topics. The project is modeled after the highly successful AMS Project ATMOSPHERE, which trains teachers in the atmospheric sciences.

Upon completion of the summer workshops, the participant teachers will provide peer-led training sessions using self-contained training modules on selected topics in physical oceanography produced by the project staff. Also an instructional resource manual of classroom activities will be produced and distributed directly to teachers. A national network of the peer trainers on physical oceanography topics will be established from teachers attending the summer workshops.

This project represents a unique partnership of a major scientific organization, a college, and military and civilian government agencies involved with operational and research aspects of physical oceanography. These groups are blending both talents and resources to enhance the education of K-12 teachers in the ocean sciences.

The presentation will focus on aspects of the first summer workshop and how this partnership is assisting in the professional development of a group of K-12 teachers as well the production of scientifically accurate resources materials for teaching physical oceanography at the precollege level.

HOLIWAY, C. E. and D. R. Smith, "The role of tropopause undulations in the development of the "Blizzard of '93" (12-15 March 1993)", *Preprints of the 14th AMS Conference on Weather Analysis and Forecasting*, Amer. Meteor. Soc., Boston, MA, 1995. 80-84.

Tropopause undulations are large scale waves in the upper atmosphere at the boundary between the troposphere and the stratosphere. These waves, with wave lengths of approximately 4000 kilometers, can have a significant effect on the development surface cyclones. As stratospheric air descends into the trough of the wave and warms the air column adiabatically, the density of the air column below decreases correspondingly. This process lowers the pressure at

the surface and allows an existing low pressure system to intensify to possibly explosive levels.

This phenomenon is reviewed for the case of the storm of 12-15 March 1993, commonly referred to as the "Blizzard of '93", which produced extensive severe weather conditions as it moved up the east coast of the United States. Using an analysis scheme called PCGRIDSD, a large scale wave observed in temperature fields for both the 300 and 200 millibar levels with warmer air located in the trough moved and deepened from the central United States to above a developing surface cyclone in the Gulf of Mexico. This wave followed the track of the storm up the east coast and helped contribute to the intensification of this cyclone. Following the example of Hirschberg and Fritsch (1991), this study examines tropopause undulations and determines its impact on the development of the 12-15 March 1993 storm.

JONES, M. K., D. R. Smith and B.L. Artery, "An example of explosive cyclogenesis over land: The "Blizzard of '93" (12-15 March 1993)", *Preprints of the 14th AMS Conference on Weather Analysis and Forecasting*, Amer. Meteor. Soc., Boston, MA, 1995, 91-96.

Explosive cyclogenesis is the rapid development of an extratropical cyclone. Applying the criteria established by Sanders and Gyakum (1980), the cyclone must have a central pressure drop of at least 24 millibars in 24 hours. Explosive cyclones are relatively rare, especially over land, compared to their more normally developing counterparts. However, they are much stronger, produce more precipitation, and are much more destructive than normal extratropical cyclones. Atmospheric conditions that enhance such rapid intensification are a strong baroclinic environment, strong low level convergence and upper level divergence, deep convection, strong upper level vorticity, and positive heat and moisture fluxes. All these factors need to combine concurrently for effective rapid deepening to classify a storm as an explosive cyclone.

An example of explosive cyclogenesis over land is the "Storm of the Century", the blizzard that occurred along the east coast of the United States between the 12<sup>th</sup> and 15<sup>th</sup> of March, 1993. An atmospheric wave moved into a baroclinic environment over the Gulf of Mexico, which had both low level convergence and upper level divergence resulting in rapid pressure falls. The low pressure center then travelled across the Gulf of Mexico, proceeded up the east coast of the United States, drawing in moisture and heat from the Atlantic, and produced a winter storm of magnanimous proportion. Strong cyclonic vorticity and positive vorticity advection combined with the other

features to create an explosive storm, with a central pressure of 960 mb. After a period of explosive deepening, these conditions either weakened or dispersed so the storm eventually began to dissipate as it moved into the Canadian maritime provinces.

This poster will examine the synoptic and mesoscale features that contributed to the rapid intensification of this storm and discuss the dynamical processes responsible for its explosive development.

MALEK-MADANI, R., D. R. Smith and C.R. Gunderson, "Synoptic manipulators in the classroom: Using student research topics in Oceanography and Meteorology to enhance teaching/learning of advanced mathematics", *Preprints of the 4th AMS Symposium on Education*, Amer. Meteor. Soc., Boston, MA, 1995, 34-36.

In the past several years the Mathematics and the Oceanography Departments at the United States Naval Academy have embarked on a program to bring state-of-the art computer technology into the classroom. This strategy for applied mathematics courses was first implemented into "Advanced Engineering Mathematics", which all oceanography majors take as their terminal mathematics course, and has now been extended to "Introduction to Ordinary Differential Equations", the course that is a prerequisite for the former.

The computer technology introduced in the curriculum requires the students to use a symbolic manipulator *Mathematica* on a network of SPARC workstations that are available to the students on a campus-wide local area network. Besides the advantages of using a sophisticated computer package and applying it to realistic physical problems, the students gain experience and knowledge from their interaction with the computer network and a UNIX-based operating system.

The introduction of the symbolic manipulator in the above two courses has required that the standard curriculum often taught in such courses be rewritten. Through the years we have made a concerted effort to blend fundamental aspects of topics in oceanography and/or meteorology with the appropriate mathematical concepts, rather than treat the science and the mathematics as separate disciplines. Weekly computer projects are used to reinforce this effort. Students, often in groups, work on problems whose solutions generally require more involvement than the exercises one finds in standard texts on these subjects. Each student is given substantial writing assignments several times during the semester. Many of the projects are motivated by models of oceanographic or meteorological phenomena that are currently used in research activities of these scientific disciplines.

Ordinary differential equations, vector and differential calculus, basic applied linear algebra, and partial differential equations are the mathematical topics that are covered in these courses. All topics are introduced in the context of fluid flows in channels and in the ocean. The Navier-Stokes equations are introduced in the advanced engineering mathematics course from which numerous projects, in which *Mathematica* plays the central role, are generated for an end-of-the-year paper.

PREYER, J. A., D. R. Smith and R. Malek-Madani, "Using *Mathematica* to enhance learning of atmospheric processes: Entrainment into cumulus clouds", *Preprints of the 4th AMS Symposium on Education*, Amer. Meteor. Soc., Boston, Maine, 1995, 41-43.

Topics in the atmospheric sciences offer excellent real-world examples of physical phenomena that demonstrate the application of advanced mathematical concepts. Since the differential equations governing the behavior of many atmospheric phenomena are quite complex, utilization of mathematical software packages, such as *Mathematica*, can be valuable tools to enhance the understanding of such mathematical concepts. Application of the software package provides a technique to solve the differential equations and graphically display the solutions for the mathematical representation of the physical phenomenon under investigation.

In this poster presentation we reconsider a classical model of entrainment of cumulus clouds described in the works of Stommel (1947) and Austin & Fleischer (1948). The entire derivations of the governing equations of this model are based on the first principles of thermodynamics. The solution to these equations for various physically significant parameter ranges is computed and results are presented via the symbolic manipulator *Mathematica*.

SMITH, P. L. K. and D. R. Smith, "A multidisciplinary approach for teaching about ENSO -- Applying the five themes of geography to topics in Meteorology and Oceanography", *Preprints of the 4th AMS Symposium on Education*, Amer. Meteor. Soc., Boston, MA, 1995, 47-49.

The El Nino-Southern Oscillation (ENSO) is an excellent example of a phenomenon that demonstrates the coupling of both the atmosphere and ocean. The climatic effects of ENSO both regionally and globally are well documented at a number of levels and from a variety of perspectives in popular publications as well as technical scientific journals. Furthermore, this phenomenon, which has gained widespread attention as

the awareness of global climate change issues has increased, offers a subject that can be treated in a highly interdisciplinary manner, providing a tremendous opportunity for integrating material across traditional educational disciplines. From the science perspective, ENSO has obvious meteorological and oceanographic connections; it is one of the best examples for demonstrating how the atmosphere and the oceans are highly interdependent. In addition, there are significant biological repercussions that result from this air-sea interaction. Moreover, the study of ENSO can be transported from the science classroom to the social studies classroom - or, better yet, can provide an opportunity for the skillful teacher to transcend traditional disciplinary boundaries to teach across the curriculum using a topic from the physical environment as the stimulus.

One strategy for linking science to social studies is through geography, particularly by utilizing the Five Fundamental Themes of Geography as the pedagogical framework. This poster will demonstrate how the "Five Themes" can be applied to the ENSO phenomenon to integrate weather, climate and ocean topics into a broader educational experience. This approach enables students to examine an environmental topic not just from a scientific viewpoint but also by considering the total impact of ENSO on the economic and cultural milieu of those affected. Such an approach is consistent with the goals of a variety of educational reform movements (e.g., Project 2061), which recommend interweaving both science and social studies as a mechanism to promote science literacy and to enhance the study of science-technology-society issues.

SMITH, D. R., C. A. Martinek, I. W. Geer and D.E. McManus, "The Maury Project: Exploring the physical foundations of Oceanography", *Proceedings of the MTS '94 Conference*, Mar. Tech. Soc., Washington, DC, 1994, 460-465.

The American Meteorological Society (AMS), in partnership with the U.S. Naval Academy, assisted by the National Oceanic and Atmospheric Administration and the State University of New York at Brockport, are conducting a four-year national teacher enhancement project. This NSF-funded program, called the Maury Project, will focus on the physical foundations of oceanography. The central component of the Maury Project is a series of two-week workshops conducted at the U.S. Naval Academy to train 72 master precollege teachers in selected physical oceanography topics. The project is modeled after the highly successful AMS Project ATMOSPHERE, which trains teachers in the atmospheric sciences.

Upon completion of the summer workshops,

the participant teachers will provide peer-led training sessions using self-contained training modules on selected topics in physical oceanography produced by the project staff. Also an instructional resource manual of classroom activities will be produced and distributed directly to teachers. A national network of the peer trainers on physical oceanography topics will be established from teachers attending the summer workshops.

This project represents a unique partnership of a major scientific organization, a college, and military and civilian government agencies involved with operational and research aspects of physical oceanography. These groups are blending both talents and resources to enhance the education of K-12 teachers in the ocean sciences.

The presentation will focus on aspects of the first summer workshop and how this partnership is assisting in the professional development of a group of K-12 teachers as well the production of scientifically accurate resources materials for teaching physical oceanography at the precollege level.

GEER, I. W., and D. R. Smith, "The American Meteorological Society's pre-college educational initiatives: A meteorological society working to make a difference", *Bulletin of the World Meteorological Organization*, 43(4), WMO, Geneva, Switzerland, 1994, 304-308.

Project ATMOSPHERE is the American Meteorological Society's precollege educational initiative in atmospheric science. This teacher enhancement program, in its fourth year of operation, is directed towards encouraging investigations of the atmospheric environment to generate interest in science,

mathematics, and technology among young people. Project ATMOSPHERE has two major components: a national network of master science teachers as educational resource agents and a materials development program. The national network of teachers, called Atmospheric Education Resource Agents (AERAs) is nearing full implementation. These teachers conduct peer-training sessions on selected meteorological topics to enhance the content background of teachers across the country. In addition, AERAs serve as agents of change, providing leadership at state, regional and national levels to promote studies of the atmospheric environment across the K-12 curriculum. To support this effort a variety of instructional resource materials have been developed.

This paper focuses on the summer workshops for teachers as well as the production of scientifically accurate resources materials for teaching meteorology at the precollege level. In addition, major accomplishments and planned activities of this program will be examined to show how it is enhancing precollege science education nationwide.

VIEIRA, Mario E. C., Assistant Professor, co-author, 1994, The Maury Project: a teacher enhancement program in Physical Oceanography, Preprints of the 4th AMS Symposium on Education, Amer. Meteor. Soc., Boston, MA.

In 1994 the American Meteorological Society launched a new educational endeavor, called the Maury Project. This teacher enhancement program focuses on another area of AMS interest - physical oceanography. The following is a description of the Maury Project and how it is designed to promote precollege instruction of the physical foundations of oceanography.

## Presentations

FOERSTER, John W., "Sentinel Specie: Biologically Active Trace Metals in the Livers of the Oyster Toadfish (*Opsanus tau*).", Coastal Zone Canada '94.

FOERSTER, John W., "Sentinel Species: Biological Active Trace Metals in the Livers of the Oyster Toadfish (*OPSANUS tau*).", Shallow Water Conference, 1995.

FOERSTER, John W., "Acoustic Assessment of the Spring Zooplankton in the Northeast North Pacific Ocean. ICES International Symposium of Fisheries and Plankton Acoustics, 1995.

GUTH, Peter L., Associate Professor and SMART, Scott D., ENSIGN, "Teaching Marine Geology and Geophysics with Microcomputer Labs", Geological Society of America national Meeting, Seattle, Washington, 24 October 1994.

LEE, Raymond L, Visiting Professor, "Mobile Collision Warning Technology for Low Visibility/Low Awareness Conditions, Presentation before National Transportation Safety Board's Invetigative Conference, Arlington, Virginia, April 1995.

MULLEN, Caitlin P., Adjunct Assistant Professor,

"Surface Flow Structure of the GS from Composite Imagery and Satellite-tracked drifters", NRL, Stennis, Stennis, Mississippi, 7 November 1994

MULLEN, Caitlin, P., Adjunct Assistant Professor, "Flow Dynamics of GS from Composite Imagery and surface drifters", Dickinson College, Carlisle, Pennsylvania, 2 December 1994.

MULLEN, Caitlin, P., Adjunct Assistant Professor, "Flow Kinematics & Dynamics of Gulf Stream from Composite Imagery", USNA, Math Department, Annapolis, Maryland, 28 March 1995.

MULLEN, Caitlin, P., Adjunct Assistant Professor, "Flow Kinematics and Dynamics of Gulf Stream from Composite Imagery", Mansfield University, Mansfield, Pennsylvania, 10 April 1995.

SMITH, David R., Associate Professor, "Major winter snow storm development: A comparison of two case studies" (with B.L. Artery), at the Joint Spring Meeting of the American Geophysical Union, Baltimore, Maryland, 30 May 95.

SMITH, David R., Associate Professor, "Atmospheric conditions that contribute to the development of a heavy precipitation event: A case study of the Southeastern U.S. (26-29 March 1994)", (with C.J. Goode), at the Joint Spring Meeting of the American Geophysical Union, Baltimore, Maryland, 30 May 95.

SMITH, David R., Associate Professor, "An examination of severe local storm development: Determining effective predictive tools", (with A.E. Hutchison), at the Joint Spring Meeting of the American Geophysical Union, Baltimore, Maryland, 30 May 95.

SMITH, David R., Associate Professor, "A climatological study of cyclone development over the East Coast of the United States and the western Atlantic Ocean", (with K.M. Jones), at the Joint Spring Meeting of the American Geophysical Union, Baltimore, Maryland, 30 May 95.

SMITH, David R., Associate Professor, "Project ATMOSPHERE: AMS precollege educational initiative - An overview of progress", (with I.W. Geer, D.R. Smith, R.S. Weinbeck and J.T. Snow), presented at the 4th AMS Symposium on Education, Dallas, Texas, 10 January 1995.

SMITH, David R., Associate Professor, "The Maury Project: A teacher enhancement program in physical oceanography", (with P.L. Guth, M.E.C. Vieira, D.W.

Jones, J.F.H. Atangan, D.S. Dillner, C.A. Martinek, A.E. Strong, E.J. Miller, R.D. Middleton and G.A. Eisman), presented at the 4th AMS Symposium on Education, Dallas, Texas, 16 January 1995.

SMITH, David R., Associate Professor, "The role of tropopause undulations in the development of the "Blizzard of '93" (12-15 March 1993)", (with C.E. Holiway), presented at the 14th AMS Conference on Weather Analysis and Forecasting, Dallas, Texas 16 January 1995.

SMITH, David R., Associate Professor, "An example of explosive cyclogenesis over land: The "Blizzard of '93" (12-15 March 1993)", with M.K. Jones and B.L. Artery), presented at the 14th AMS Conference on Weather Analysis and Forecasting, Dallas, Texas, 16 January 1995.

SMITH, David R., Associate Professor, "Synoptic manipulators in the classroom: Using student research topics in oceanography and meteorology to enhance teaching/learning of advanced mathematics", (with R. Malek-Madani and C.R. Gunderson), presented at the 4th AMS Symposium on Education, Dallas, Texas, 16 January 1995.

SMITH, David R., Associate Professor, "Using *Mathematica* to enhance learning of atmospheric processes: entrainment into Cumulus Clouds", (with J.A. Preyer and R. Malek-Madani), presented at the 4th AMS Symposium on Education, Dallas, Texas, 16 January 1995.

SMITH, David R., Associate Professor, "A multidisciplinary approach for teaching about ENSO -- Applying the five themes of geography to topics in meteorology and oceanography", (with P.L.K. Smith), presented at the 4th AMS Symposium on Education, Dallas, Texas, 16 January 1995.

SMITH, David R., Associate Professor, "Project ATMOSPHERE and the Maury Project - Partnerships to enhance K-12 science education", invited presentation for the USNA chapter of Sigma Xi, Annapolis, Maryland, 20 October 1994.

SMITH, David R., Associate Professor, "An overview of precollege educational programs in the atmospheric and oceanic sciences", presented at the 9th AMS/UCAR Biennial Heads and Chairs Meeting, Boulder, Colorado, 11 October 1994.

SMITH, David R., Associate Professor, "The Precollege educational initiatives of the American Meteorological Society: Project ATMOSPHERE and

the Maury Project, (with I.W. Geer), presented at the Fall '94 AGU Chapman Conference on Scrutiny in Undergraduate Education, Washington D.C., 17 September 1994.

SMITH, David R., Associate Professor, "The Maury Project: Exploring the physical foundations of oceanography", (with C.A. Martinek, I.W. Geer and D.E. McManus), presented at the MTS '94 Conference, Washington, D.C., 8 September 1994.

STRONG, Alan E., Adjunct Assistant Professor, and Tim M. WINTER, 1/C Midshipman, "High-resolution satellite climatology," Annual Meeting of the American Meteorological Society, Dallas, Texas, 17 January 1995.

STRONG, Alan E., Adjunct Assistant Professor, and Greg K. EMERY, 1/C Midshipman, "Coral bleaching events of 1994 and high SST," Spring Meeting of the American Geophysical Union, Baltimore, Maryland, 1 June 1995.

STRONG, Alan E., Adjunct Assistant Professor, and Tim M. WINTER, 1/C Midshipman, "High-resolution satellite SST climatology," NOAA/NESDIS/ORA Seminar, Camp Springs, Maryland, 11 May 1995.

STRONG, Alan E., Adjunct Assistant Professor, and Greg K. EMERY, 1/C Midshipman, "Coral bleaching events of 1994 and high SST," NOAA/NESDIS/ORA

Seminar, Camp Springs, Maryland, 11 May 1995.

VIEIRA, Mario, E. C., Assistant Professor, "What is an Estuary? How does it work?", Washington College, Chestertown, Maryland, 2 May 1995.

VIEIRA, Mario, E. C., Assistant Professor, "A cooperative Research Program between the U.S. Naval Academy and the U.S. Environmental Protection Agency", Second Annual marine & Estuarine Shallow Water Science and Management Conference, Atlantic City, New Jersey, 3-7 April 1995.

VIEIRA, Mario E. C., Assistant Professor, "The Severn River Estuary: A Preliminary Investigation of its circulation", Spring meeting of the Atlantic Estuarine Research Society, Solomons, Maryland, 23-25 March 1995.

VIEIRA, Mario E. C., Assistant Professor, "The Case of the Brown Tide Killer: A Search for the Smoking Gun", Long Island University, Southampton College, Southampton, New York, 10 November 1994.

VIEIRA, Mario E. C., Assistant Professor, "Outreach and Cooperative Programs in Oceanography at the U.S. Naval Academy", Fall meeting of the Atlantic Estuarine Research Society, Ocean City, Maryland, 3-5 November 1994.

# Physics

Professor Donald J. Treacy  
Chair

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**D**uring the 1994 - 1995 academic year the Physics Department was very productive. There were two Trident Scholars, several midshipman independent research projects and an impressive array of faculty research. The topics represented in this research effort ranged from applying particle accelerator technology to historical and ecological problems to calculating the interaction of the comet Shoemaker - Levy 9 with the magnetosphere of Jupiter. The areas of concentration are astronomy, physical and non-linear acoustics, electrical and structural properties in condensed matter, non-linear optics, current educational initiatives and accelerator technology applied to a wide-ranging field from nuclear physics to historical studies. This research was made possible both by the excellent facilities in the department as well as cooperation with other laboratories.

This work is of immeasurable importance in maintaining the exciting intellectual atmosphere which carries into the classroom and becomes apparent to our students. The student involvement in this effort is designed to give the midshipmen a real lesson in the rigors and excitement of probing new areas of science. The results are apparent because they have resulted in invited presentations and well-received talks. It is particularly gratifying to see a paper appear which demonstrates the collaboration of officers who contributed three years ago when they were midshipmen along with our current class of midshipmen.

The Physics Department's research program is vital, wide-ranging, and has continuity. This bodes well for continued excellence.

## Sponsored Research

### Acoustics and Infrared Studies

Researcher: Professor Donald W. Brill  
Sponsor: Naval Surface Warfare Center, Annapolis, Maryland

A study was made of the acoustic reflection from a two-layered lossy coating. This led to a general treatment of multilayered coatings using a matrix formulation which rendered a transfer function matrix for each interface which relates the acoustic plane waves traveling in opposite directions across the interface. Finally a Mathematica program was written to produce reflection, transmission and absorption

coefficients for a two-layered coating mounted on a steel backing in water.

An infrared study was made which started out with a general discussion and ended with a calculation of the vibrational modes of both CO and CO<sub>2</sub>. The energy of these modes is contained in the IR vibrational spectra of these molecules.

### Development of a Coincident RBS-PIGE System with High Depth Resolution

Researcher: Professor Francis D. Correll  
Sponsor: Naval Research Laboratory, Washington, DC

Several ion-beam-analysis (IBA) techniques are commonly used to assist in the development of new or improved materials. Rutherford Backscattering Spectrometry (RBS) gives high-resolution depth

profiles of sample constituents, but often cannot distinguish between constituents of similar mass. Particle-Induced Gamma-ray Emission (PIGE) easily identifies individual elements and even isotopes, but

does not produce depth profiles. Unfortunately, no single technique with this combination of capabilities appears to have been developed.

The objective of this work was to combine RBS and PIGE to obtain the desired capabilities. The key idea was to detect an ion scattered from a sample atom in time-coincidence with a gamma ray produced in the same event. Depth profiles could be obtained from the ion-energy spectra, as in conventional RBS, while elemental identification could be obtained from the gamma-ray spectra, as in PIGE. But because ions and gamma rays are detected in coincidence, it should be possible to correlate the ion-energy spectra with individual gamma-ray energies, producing separate, high-resolution depth profiles of the different sample constituents even if their masses are very similar.

In FY94, a new detection system was assembled, consisting of a high efficiency NaI gamma-ray detector, a large-solid-angle silicon ion detector, and a new, very flexible multi-parameter data acquisition system that employs versatile CAMAC electronics and a single Macintosh computer. A new software instrument for the KMAX<sup>a</sup> data-acquisition environment was written and tested. Experiments with the new system were initially performed at Naval Academy Tandem Accelerator Laboratory (NATALY) using 4.5-MeV helium ions on a thick Fe target. The detectors performed well and good singles spectra were observed, but there was no clear signature of true coincidences.

The detectors, electronics, and computer were transported to the 3-MV tandem accelerator facility at the Naval Research Laboratory. There, a thick Fe target was bombarded with 200-300 nA of 8-MeV helium ions, and scattered ions were detected at 168° from the beam direction in the silicon detector while 847-keV gamma rays from the first excited state of <sup>56</sup>Fe were detected at 135° in the NaI detector. A very clear signature of true coincidences was observed in the form of a narrow (3 ns FWHM) peak in the time spectrum with a true-to-accidental ratio of about 7:1 and an event rate of about 3.5 per second. Moreover, the sorted particle spectrum was consistent with the uniform profile expected of a thick Fe target. When the beam energy was reduced to 5 MeV to simulate the earlier experiments at NATALY, the gamma-ray yield dropped by a factor of 500, the event rate dropped by a factor of 200, and the peak in the time spectrum disappeared. This result demonstrates the importance of high beam energies for efficient gamma ray production.

A special sample, consisting of 400-keV Fe ions implanted into Co, was made to demonstrate the ability of the technique to profile an element in a sample of similar mass. Experiments with the implanted target are continuing. Additional experiments with other ions, including protons, other samples, including GaAlAs, and with a high-resolution germanium gamma-ray detector are planned.

## Mine Counter Measures

Researcher: Professor Douglas W. Edsall,

Sponsor: Johns Hopkins Applied Physics Laboratory, Laurel, Maryland

An abstract of this work can be obtained from the sponsor.

## Comparison of Two Methodologies for Analysis of Extended Sources of Magnetic Fields

Researcher: Associate Professor Irene M. Engle

Sponsor: Naval Surface Warfare Center-Carderock, Annapolis, Maryland

It was desired to examine some possible causes of discrepancies in results of applying two methodologies to the calculation of multipole moments associated with a vessel as an extended source. The underlying theory equations were re-derived from basic principles and then compared with the original documentation to determine if any substantive errors existed in the published information. The computer programs based upon the theories were examined for evident programming errors. No substantive disagreements were found with the previously derived theory. No

computer programming errors have as yet surfaced. However, in the process of deriving the equations from basic principles, it was noted that the expansions used in the finite element method (FEM) depend very substantively upon the assumption of a "far-field" neighborhood for each of the terms in order to provide a reasonable functional representations of the sources used in the fitting of magnetic field data. As the test data are generally taken in the "near-field" neighborhood within several boat-lengths of a vessel, disagreements are expected on this basis alone; when



added to the independent uncertainties associated with the measurements, discrepancies on the order of 100%

cannot be entirely ruled out, although order of magnitude agreement should be present in each case.

## **Propagator Study of Some Simple Resonance Phenomena**

Researchers: Associate Professor John P. Ertel,  
and Joseph W. Dickey

Sponsor: Naval Surface Warfare Center, Annapolis, Maryland

This study involves the first and second level development of the Propagator Solution to several standard idealized acoustics problems in Physics. In the first level, some simple physics problems normally solved via eigenvalue methods were completed to validate the technique unambiguously. These problems have very well known and accepted solutions which the Propagator method will reaffirm. This first level should be completed during the summer intersessional period under Code 804.1 funding. At the second level of this

project, several very idealized eigenvalue resonance problems (examples: 1D, a perfectly uniform string; 1D, a uniform string with periodic bead masses; 2D, multiple simply connected quadrilateral structures; etc.) will be solved using the Propagator method which may then very matter-of-factly be extended to include deviations in symmetry. The well known perturbation methods of extending the standard eigenvalue solutions are, in contrast, long, difficult, and, in many cases, fail to reliably converge.

## **A Propagator Study of Resonance Phenomena**

Researchers: Associate Professor John P. Ertel,  
Gideon Maidanik, and Joseph W. Dickey

Sponsor: Naval Surface Warfare Center, Annapolis, Maryland

The current studies involve the development of the Propagator Solution to several acoustics problems of interest to the Navy and the numerical evaluation of certain significant measurable parameters. Of the parameters evaluated, the "partial radiation efficiency"

has proved most interesting in that it predicts that damping does not always reduce radiated power. In fact, it has been shown that the radiated power may well be significantly enhanced at certain frequencies when damping is arbitrarily applied.

## **Electrical Properties of Polymers**

Researchers: Professors John J. Fontanella and Mary C. Wintersgill  
Sponsor: Du Pont de Nemours, Co., Wilmington, Delaware

The audio frequency dielectric constant and loss have been measured over the temperature range 5.5-300K for various types of polymers. Several new relaxations

were observed and the activation parameters for each were determined.

## **Complex Impedance Studies of Ion Exchange Membranes**

Researcher: Professor John J. Fontanella  
Sponsor: Office of Naval Research, Washington, DC

The primary objective of this work is to gain insight into ion motion in ion exchange membranes via complex impedance measurements. Work has begun on NAFION and will continue. Audio frequency impedance and admittance measurements are being carried out from 10 Hz to 108 Hz in vacuum from 0.008 K to 400 K and at pressures up to several kilobars over the temperature range 100-400K using

state of the art devices. In the vicinity of room temperature, both higher (to 1 GHz) and lower (to 1 MHz) frequency measurements will be carried out. Thus, electrical transport and relaxation will be studied over a wide range of temperatures and pressures. Auxiliary measurements such as thermally stimulated depolarization current and thermal analysis measurements including differential scanning

calorimetry, thermomechanical, thermogravimetric, and dynamic mechanical relaxation studies will also be carried out where appropriate. Optical and infrared

absorption and x-ray diffraction measurements will also be performed.

## Reactor Noise Analysis

Researcher: Midshipmen 1/C John Ventura, USN

Adviser: CAPT Matthew Forsbacka, USAF

Sponsor: Trident Scholar Program

The dynamic characteristics of a TRIGA reactor were investigated using noise analysis techniques. While the reactor operated at steady state, an ex-core reactivity perturbation device was oscillated in a pseudo random

manner. By analysis of the data from the oscillator driver and the neutron detector output in the Fourier-transform domain, the reactor transfer function was obtained.

## Instrumentation to Generate a Two-Phase Turbulent (Bubble) Submerged Water Jet for Flow Noise Measurements

Researcher: Professor Murray S. Korman

Sponsor: Office of Naval Research, Washington, D.C.

It has been demonstrated that the near-field pressure spectrum (generated by a turbulent submerged water jet) is enhanced when the turbulent flow is modified to become a two-phase flow containing air bubbles. [Proceedings of the 14th ICA, Beijing, China, Acoustica 76, supplement to No. 4, May (1992), paper B6-1, p. 70.] An amplification factor  $G = \frac{\text{two-phase } df}{\text{single-phase } df}$  is measured as a function of the gross void fraction  $\alpha$  of the air bubbles. Results showed that  $G \approx 2$  and  $G \approx 20$  at  $\alpha = 0.0065$ . The range of void fraction was limited due to the use of the bubble maker (located at the jet nozzle entrance)

which consisted of a fritted ceramic disk that was housed in a glass Buchner funnel and fed compressed nitrogen gas. It is possible to improve this apparatus by using carbonated water at high pressure in a nozzle that consists of an array of small holes in a thin circular plate. This arrangement can be controlled to yield small bubbles with an average diameter of about 100 microns in water. Larger void fractions are possible and the necessary constraint of having the resonant bubble frequencies well above the region of the low frequency flow noise spectrum ( $< 500$  Hz) is obtained. A brief video tape was prepared.

## Spatially Resolved Self-Pumping in Photorefractive Materials

Researcher: Associate Professor Steven R. Montgomery

Sponsor: Naval Academy Research Council (ONR)

Self pumping in photorefractive crystals is easily observed for continuous wave laser beams and is well documented. During a previous period of NARC sponsored funding it was found that self pumped phase conjugation is easily observed in BSKNN when the input laser beam consists of pulses of about 120 picoseconds duration and 82 MHz repetition rate from a modelocked argon ion laser. In fact, the response is very similar to that from a CW beam. However, self pumping with trains of 3 picosecond pulses with the same repetition rate derived from the synchronously pumped dye laser produce only a very weak self pumped response from the crystal. It is the difference in

behavior between the CW and pulsed cases that is the primary focus of this study. The main objective is to understand why the self pumping response in photorefractive crystals is different for CW laser beams and modelocked pulse trains. Since it occurs completely inside the crystal it is difficult to probe self pumping. Short pulses can provide a spatial or temporal probe so that better physical models can be developed and tested. Self pumping is rather a slow process that takes several seconds to thirty minutes to achieve. Better understanding may allow the development of schemes for enhancing the speed or efficiency of this process.

## Electromagnetic Signatures of Vessels

Researcher: Professor Robert N. Shelby  
Sponsor: Naval Surface Warfare Center, Annapolis, Maryland

Studies of the electromagnetic signatures of naval vessels were conducted. Attempts were made to model

signatures of vessels of interest. Specifics of the project are classified.

## Properties of Electrode Materials and Ion-Exchange Membranes

Researchers: Assistant Professor Phillip E. Stallworth  
and Professor John J. Fontanella  
Sponsor: Office of Naval Research, Washington, D.C.

The goals of the project are to study the structure and electrical properties of electrode materials and continue work on the electrical properties of ion-exchange membranes. X-ray diffraction, nuclear magnetic resonance (NMR) and electrical conductivity studies will be carried out over a wide range of temperatures and pressures on select electrode compounds. In addition, nuclear quadrupole resonance (NQR) techniques will be developed for future use with these

materials. For ion exchange membranes, work will be carried out on NAFION and NAFION-like materials. The materials will be studied under a variety of conditions including exposure to various levels of relative humidity and methanol; and complex impedance measurements will be carried out over a wide range of frequencies, temperatures and pressures. All results will be compared with NMR data from Dr. S. G. Greenbaum at Hunter College.

## $^{23}\text{Na}$ NMR Studies of $\text{Na}_x\text{CoO}_2$ Cathode Materials

Researchers: Assistant Professor Phillip E. Stallworth, S. Greenbaum,  
Y. Ma, L. Ding, M. Doeff and S. Visco  
Sponsors: Army Research Office and Office of Naval Research

Two samples of oxidized sodium cobalt oxide,  $\text{Na}_x\text{CoO}_2$  (where  $x=0.3$  and  $0.7$  prepared by a glycine-nitrate combustion method), have been obtained and measurements conducted at  $150^\circ$  to  $-150^\circ$  centigrade and at different frequencies (79.6 MHz and 54.5 MHz). We find that the  $^{23}\text{Na}$  response is strongly influenced by both sodium content and temperature. In general, spectra show an intense paramagnetic-shifted response characterized by second-order quadrupole broadening and a diamagnetic-shifted weaker response. This suggests that there are at least two dominant inequivalent sodium environments in these materials.

Considering the more intense responses at room temperature, the second-order quadrupolar broadening is present along with paramagnetic shifts attributed to spins localized on cobalt atoms. The second-order quadrupolar splitting is resolved for  $x=0.7$ ; whereas the lineshapes obtained for  $x=0.3$  do not

show the resolution and indicate a more varied distribution among the sodium sites and/or a greater broadening effect due to paramagnetic interactions. Lineshapes for the two compositions behave somewhat differently as the temperature is changed. Linewidths for  $x=0.3$  increase slightly as the temperature is reduced; however, the linewidth increases to a greater extent for  $x=0.7$  accompanied by a loss in resolution of the second-order quadrupolar features. Spin-lattice relaxation time measurements also reflect the presence of inequivalent sodium environments, with one distribution of sodium environments characterized by long relaxation times (10 to 200 ms) and another set of environments characterized by much shorter times (0 to 500  $\mu\text{s}$ ). The data suggest that 50% or more of the sodium environments are motionally averaged and that motional averaging occurs even at temperatures as low as  $-150^\circ$  centigrade.

## Studies of the Imaging and Amplification of Low Intensity Light

Researchers: Professor Lawrence L. Tankersley and  
M. D. Duncan  
Sponsor: Naval Research Laboratory, Washington, DC

All work undertaken was in support of ongoing efforts at the Naval Research Laboratory in Code 5640. This year, studies of optical detection and analysis of debris in turbine engine lubrication fluids, imaging through turbid media and light amplification based on quantum processes such as stimulated Raman scattering were continued. An effort to use quantum well devices for

pattern recognition was initiated. Elements included in the program were: low-light level amplification and imaging, lubricant optical transmission studies, Fourier transform image analysis, applications to biological studies and engine oil analysis, quantum well photorefractive image correlators, development of support electronics for engine test-stand studies.

## **Fragmentation of Isovector Quadrupole Vibrations In Ce-142 And Nd-144**

Researchers: Associate Professor Jeffrey R. Vanhoy, in collaboration with  
Midshipman 1/C Bernard T. Meehan, USN, Midshipman 2/C Brian H. Benedict, USN, Lieutenant Gerhard S. Schoenthal, USN, Ensign Bryan Haas, USN, Sally F. Hicks, Carl Lundstedt, C.M. Davoren (Univ Dallas), S.W. Yates, and M.T. McEllistrem (Univ Kentucky)  
Sponsor: National Science Foundation

Studying the properties of low-lying nuclear states reveals much information about the behavior of nuclear matter. In the heavier nuclei where many nucleons are involved, it is not possible to keep track of the individual particles and one is forced to use almost exclusively the collective model description. The collective model treats the nucleus as a fluid undergoing vibrations and rotations. But in fact, the nucleus is composed of neutron and protons -- distinguishable particles, so the nucleus should be considered as a mixture of two separate fluids in certain situations. There are several normal modes of oscillation which could occur. The exotic oscillations are commonly referred to as mixed-symmetry states or isovector states. As in many systems undergoing oscillations, it is becoming apparent that the actual motion of the nucleus is not in pure normal modes. The extent of the

fragmentation of isovector vibrations has not been measured in spherical nuclei. This series of experiments consider the nuclei  $^{142}\text{Ce}$  and  $^{144}\text{Nd}$ .

During the previous year, the excited levels of  $^{144}\text{Nd}$  have been studied using the  $(n,n'\gamma)$  reaction. Excitation functions, angular distributions, and Doppler shifts were measured for observed  $\gamma$ -rays for levels up to an excitation energy of 3.3 MeV; spins, multipole mixing, and branching ratios were deduced. Comparison of experimental transition rates with available IBM2 and PCM model calculations clearly indicates that the low-lying levels require co-existing vibrational and single particle degrees of freedom. Combined with previous information in  $^{142}\text{Ce}$ , candidates for the complete quadrupole-octupole coupled multiplet are identified.

## **Development and Application of a Scanning Ion Microprobe**

Researcher: Midshipman 1/C Bernard Timothy Meehan, USN  
Faculty Advisors: Associate Professor Jeffrey R. Vanhoy,  
Professor Francis D. Correll  
Sponsor: Trident Scholar Program

A complete scanning ion microprobe system was developed for use in the Naval Academy Tandem Accelerator Laboratory. The microprobe employs a computer-controlled positioner to scan a sample while it is bombarded with a finely-focused particle beam. The beam excites characteristic X rays from the sample atoms. The X-ray yields are converted to elemental concentrations. The concentration and position data are then used to create two dimensional surface concentration maps, which are analogous to microscope views of the sample.

The microprobe was tested using a 200-mesh

transmission electron microscope grid. The diameter of the beam spot on the sample surface was found to be approximately 30  $\mu\text{m}$ .

The capabilities of the microprobe were demonstrated by measuring the positional variation of elemental concentrations in several inclusions of the Allende meteorite. These inclusions are thought to predate the formation of the solar system. Extensive position dependent concentration data may eventually provide information on the formation mechanisms and temperature and radiation history of meteorites.

## Electrical Properties of NLO Polymer Materials

Researcher: Prof. Mary C. Wintersgill  
Sponsor: Office of Naval Research

Photonics is increasingly being used or proposed for use in a variety of applications including high speed fiber optic communications, computer interconnects, data distribution networks, fiber optic sensor systems, phased array radar, inertial guidance and underwater communications. Many of these systems either require or would benefit from nonlinear optical (NLO) materials that can be used in devices to modulate the amplitude and phase of light. We investigated two types of samples, designated 1400-95 and 1455-93, which are PMMA-type polymers with a-cyanocinnamoyl chromophores. Both differential scanning calorimetry (DSC) and electrical relaxation measurements were made on each sample, on the as-received material and after heat treatment. For the

first sample, three relaxations were observed in the as-received material, and activation energies were obtained for the two lower temperature peaks. The relaxations were not visible after heat treatment at a temperature slightly below the glass transition temperature. It was concluded that the peaks were probably not directly associated with the second harmonic generation mechanism directly since the activation energies were not of an appropriate size. The second sample was very lossy, so that relaxation peaks were not observable. The data were fitted with a VTF equation and standard parameters were determined. The high level of the conductivity was taken to be indicative of a high concentration of free ions in the material.

## Independent Research

### A Southern Hemisphere Survey of Ti II in the Galactic Disk

Researcher: Professor C. Elise Albert

During a recent study of interstellar Ti II absorption toward southern hemisphere halo stars (Albert et al., 1994, *Astrophysical Journal* 437, 204), we also observed both Ti II and the ultraviolet doublet of Na I toward 12 bright reddened southern stars in the galactic disk. The ultraviolet sodium lines are particularly interesting since they do not suffer the extreme saturation that affects the well-studied optical doublet.

Although the galactic disk has been surveyed thoroughly in the northern hemisphere, the physical characteristics of interstellar gas in the southern hemisphere are still unstudied. We observed an additional two dozen southern disk stars with the 1.5 meter telescope of the Cerro Tololo Inter American Observatory, Chile, in January 1995 and are in the process of analyzing the complete data set.

### PIXE Analysis of Artifacts Recovered from H.M.S. DeBraak

Researcher: Professor Francis D. Correll

The Delaware State Museum is assembling a team of researchers and conservators to document as fully as possible the hull and fittings of the H.M.S. DeBraak, a British Man-of-War which sank in a squall off Cape Hatteras in 1798. The Naval Academy Tandem Accelerator Laboratory will contribute to this effort by performing particle induced x-ray emission (PIXE) analysis of a variety of metal fittings recovered from the

hull, specifically bolts, fasteners, braces, pins, sheathing, and sheathing nails. The goal of the study is to investigate technological advances in alloys used in ship construction during the latter half of the 18th Century.

Preliminary measurements have begun. Measurements will continue, possibly involving midshipman participation, during the next year.

## **Electrical Properties of Solid Polymer and Gel Electrolytes**

Researcher: LCDR Charles A. Edmondson, USN

Complex impedance studies of solid polymer and gel electrolytes provide information on the ionic transport properties of these materials. Successful development of high efficiency methanol fuel cells requires the use a polymer electrolyte barrier which promotes the

transport of ionic components and inhibits the wholesale transport of methanol throughout the cell. These studies evaluate the conductivity of various polymer electrolytes over a wide range of temperatures and pressures.

## **Investigation of the Human Voice Mechanism**

Researchers: Professor Samuel A. Elder, and  
P. E. Castellanos, University of Maryland, Medical Center

This is a reexamination of the theory of human voice mechanism, a joint effort by an acoustician and a otolaryngeal surgeon, combining expertise in the acoustical and physiological aspects of the phenomenon. An essential element in all voice mechanism models is the role of laryngeal folds in production of the repetitive sound pulses that drive the resonant cavities of the mouth, pharynx and trachea.

Previous workers have concentrated on the volume flow source capabilities of the glottis, neglecting the possibility of dipole and higher sources. There are now reasons to believe that dipole, or force-dominated, sources may play a key role in some subtle aspects of voice quality, such as stress-related markers in recorded or telemetered speech.

## **Magnetospheric Physics**

Researcher: Associate Professor Irene M. Engle

There are several projects upon which are thought about or worked upon intermittently. Modeling, from first principles, a representation of the Jovian magnetosphere during a semi-inflated state, as observed during the Voyager II flyby. A paper for adaptation to the Ulysses encounter with Jupiter was written, but withdrawn for further work, upon seeing some of the magnetometer data. The expanded version of the Voyager III Era magnetosphere field model was the one most applicable to correct predictions and useful data analysis for the July 1994 Shoemaker-Levy 9 Encounter with the Jovian magnetosphere.

A new look was taken at the Mercury magnetospheric field, in response to a published review on Mercury which contains some conclusions which are not supported by this investigator's experience. Also, I was contacted by an investigator interested in obtaining time dependent configuration modeling for analysis of some more recently observed photo-ionization of heavy ions (especially sodium) near the disc of Mercury. I have been invited to present my work at the European Space Agency Workshop for planning a new mission to Mercury.

Modeling, from first principles, or by scaling from a function set, self-consistent, three-dimensional

global magnetospheres of Uranus and Neptune.

I have been adapting alternate sets of orthogonal functions for three-dimensional representation of magnetospheres for earth and other planets with intrinsic planetary magnetic fields.

Determining the relation of observed temporal variations of magnetospheric configurations to the proximate causes and consequential phenomena; investigations of the mechanisms for transport of particles, momenta, and energy related to the aforesaid phenomena.

A representation of the Saturnian magnetosphere as observed during the Pioneer 11 and Voyager I and II flybys has modeled, from first principles. An expanded (from original version) paper written jointly with Sylvestre Maurice has recently been accepted for publication by the Journal of Geophysical Research. The model has been adopted by the CASSINI mission investigators as their basic magnetic field model for planning purposes for the planned orbiting mission to Saturn. Several presentations based upon the work have been made in Europe as well as an invited update. Current projects include incorporating a non-equatorial plane incidence of the solar wind (Trident Project of Mark Skubis) and affixing a

realistic model of a magnetotail to the global model  
(Thesis project of Emanuel Chaponniere, Université

Paul Sabbatier, Toulouse, France).

## Measurement of the Ratio $hc/k$ by Observation of Thermal Radiation

Researcher: Associate Professor James R. Huddle

The purpose of this experiment is for students to measure the ratio  $hc/k$ , where  $h$  is Planck's constant,  $c$  is the speed of light, and  $k$  is the Boltzmann constant. These three constants play fundamental roles in modern physics. The measurement is carried out by observing the intensity of radiation from the tungsten filament of a flashlight bulb at a known temperature as a function of wavelength. The temperature of the filament can be measured either by using an optical pyrometer or by measuring the voltage drop across the filament and current through it and using the known resistivity of tungsten as a function of temperature. A 1/2-meter

Jarrell-Ash spectrometer with a 1P28 photomultiplier tube fitted to the exit slit is used to measure the relative intensity of the light from the flashlight bulb at several wavelengths in the optical region. A graph is made of the quantity  $\ln(S\lambda^5/\epsilon)$  vs  $(1/\lambda)$ , where  $S$  is the relative intensity as measured by the 1P28 signal,  $\lambda$  is the wavelength, and  $\epsilon$  is the filament's emissivity, known from published data. The slope of the line fitted to this plot is  $-hc/kT$ ,  $T$  being the measured filament temperature. Typical values obtained by students using this method are accurate to within about 7% and precise to within about 10%.

## Measurement of the Ratio $h^2/em_e$ by Observation of Electron Diffraction

Researcher: Associate Professor James R. Huddle

The purpose of this experiment is for students to measure the ratio  $h^2/\sqrt{em_e}$ , where  $h$  is Planck's constant,  $e$  is the fundamental charge, and  $m_e$  is the electron rest mass, by using electron diffraction. Using a commercial cathode ray tube apparatus designed for demonstrating electron diffraction, electrons are accelerated to kinetic energies of 5, 6, 7, and 8 keV. The electrons are diffracted by an aluminum target, and diffraction rings are created on a screen. The electron's de Broglie wavelength is given by  $\lambda = h/\sqrt{2em_e V}$ , where  $V$  is the accelerating potential. The wavelength can also be determined using the Bragg relation,  $\lambda =$

$ar/D(h^2+k^2+l^2)^{1/2}$ , where  $a$  is the known lattice constant for aluminum,  $r$  is the radius of the diffraction ring,  $D$  the known distance from the target to the screen, and  $h$ ,  $k$ , and  $l$  are the Miller indices of the lattice planes responsible for the diffraction ring. Therefore, a plot of the radius of the ring caused by diffraction by one set of lattice planes as a function of  $\sqrt{1/V}$  is linear, with the slope proportional to the quantity desired. An average value for  $h^2/\sqrt{em_e}$  can be obtained by weighting values derived from several rings. Typical values obtained by students are accurate to better than 3% and precise to better than 4%.

## Flash Spectroscopy of the Solar Chromosphere

Researcher: Associate Professor James R. Huddle

Solar spectroscopy gives information about the elemental composition and temperature of the various parts of the sun. Because the photosphere is brighter than the chromosphere by a factor of about one million, spectroscopy of this important part of the sun is extremely difficult except while the sun's photosphere is obscured by the moon during total solar eclipses. The problem is compounded by the facts that total solar eclipses are rare and of a few minutes' duration, that the chromosphere is visible for only several seconds during each eclipse (hence, the term "flash spectrum"), and

that the spectroscopist can not know until the emulsion has been developed - long after the eclipse has ended - whether or not the exposure of the spectrum has been adequate. The CCD chips in modern camcorders have high sensitivities and have a large advantage over film cameras in that one can see what is being recorded in real time, and can therefore make exposure adjustments while the spectrum is being captured. Experiments done by this investigator using Geissler tubes filled with hydrogen and helium indicate that it might be feasible to capture chromospheric and coronal spectra using a

holographic diffraction grating fitted over a camcorder lens. This may allow eclipse timing information to be recorded at the same time. The principle investigator is

planning a trip to India to attempt to record a flash spectrum during the 24 October 1995 total solar eclipse.

## **Low-field CW and Pulsed NMR at USNA**

Researcher: Associate Professor Phillip. E. Stallworth

Efforts are underway to upgrade facilities in order to conduct low-field nuclear magnetic resonance (NMR) experiments at the Naval Academy. The project will bring 0 to 21 kG electromagnet on line, and repair and upgrade existing pulsed and continuous wave (CW) NMR/nuclear quadrupole resonance (NQR) equipment. The Varian electromagnet needs to be interfaced with a 1 ppm field stabilization unit (Walker Scientific rotating coil unit and console). In order for this unit to operate in sweep mode the accompanying power supply must be custom interfaced. Currently, the magnet is cooled using continuously running tap water. A more-efficient/less-wasteful method of temperature maintenance is proposed by incorporation of a Neslab water chiller. The Matec Gated Amplifier pulsed NMR/NQR unit is currently being repaired and should be functional in the fall. This device will be used with the pulsed NMR/NQR spectrometer to measure NQR

resonances and to measure NMR spin-lattice relaxation times. Use of a Ritech 1-45 MHz pulsed spectrometer is proposed in order to obtain low-field NMR spectra utilizing quadrature detection. Once this unit is obtained, efforts will be made to customize the spectrometer for use at higher frequencies. A continuous wave receiver/transmitter unit is being custom made for use with our crossed-coil Varian NMR probes. This device will be used in conjunction with a Kepco power supply, Nicolet signal averager, NMR probes, Matlab computer software and various lineshape simulation programs in gathering and evaluating low-field fast-passage NMR lineshapes. When the electromagnet is used in sweep mode, continuous wave NMR experiments will be performed utilizing the above equipment along with a lock-in amplifier.

## **Research Course Projects**

### **Development of Undergraduate Laboratory Experiments in Ballistics and Elementary Mechanics**

Researcher: Midshipman 1/C Michael Horn, USN  
Adviser: LCDR Charles A. Edmondson, USN

The connection between theory and experiment is often the key to capturing the interest of first year physics students. A series of student laboratory experiments were developed which use a low cost, moderate velocity (50 m/s) projectile launchers. In these laboratories students can explore, in an exciting fashion, two dimensional motion, impulse and momentum, friction and drag and conservation of energy. The

projectile launcher was interfaced with existing Macintosh computers and instrumented with pressure transducers and laser diode switches for time of flight measurements. Data sets are collected, interpreted and fundamentals of error analysis are explored using the same student software found in other departmental experiments.

### **Modeling the Saturnian Magnetopause for the CASSINI Mission**

Researcher: Midshipmen 2/C Mark Skubis, USN  
Faculty Advisor: Associate Professor Irene M. Engle

Maurice and Engle have constructed idealized three-dimensional model of Saturn's magnetosphere. The total magnetospheric field is a sum of three contributions; the first two contributions are internal, in

the form of a planetary dipole and an equatorial ring current deduced from Voyager spacecraft observations. A third contribution to that field, resulting from the interaction of the Solar Wind with the Saturnian



magnetosphere was incorporated in their model. From the balance between the Solar Wind ram pressure and the magnetospheric pressure, simultaneous models of the magnetopause shape and of the magnetic field due to the surface currents on the magnetopause were developed. Their work extended the range of a physically reliable model of Saturn's magnetosphere in latitudinal and longitudinal directions from regions where there had been observations to regions where there have not yet been observations. In their initial modeling, Maurice and Engle assumed an incoming Solar Wind in a direction normal to the magnetic axis. This limitation was acceptable for the Voyager missions, because at the time of the Voyager flybys, the Saturnian equatorial plane contained the sun-planet line. However, although the Saturn magnetic axis is nearly parallel to the rotation axis, the rotation axis is tilted

26.7° away from the normal to the Saturn orbital plane. Thus, during a Saturn sidereal period (29.46 years) the orientation of the magnetic axis relative to the sun effectively precesses by one complete cycle for each orbital cycle. The CASSINI mission has a planned launch in 1997 and will orbit about Saturn from 2004 through 2007. During the period of the in situ observations, the declination of the Sun as seen from Saturn will range from about 25° at the time of the insertion of the spacecraft into Saturn orbit to about 7° toward the end of the mission. This preliminary work and the subsequent Trident Scholar project will extend their work by constructing a self-consistent model of the magnetopause of Saturn when its magnetic axis is oriented relative to the Sun-planet in the manner anticipated in 2004.

### **Solar Photography with a Questar Telescope**

Researcher: Midshipmen 1/C Jorge F. Garcia, USN  
Faculty Adviser: Associate Professor James R. Huddle

It is discussed in most astronomy textbooks that the sun's rotation period of approximately 29 days has been measured long ago by observing the motion of sunspots on the solar disk. The purpose of this one-credit-hour student project was to recreate certain aspects of this measurement. We realized at the outset that in order to obtain meaningful results, the motion of many sunspots must be followed in order to average out the random motions of individual sunspots across the sun's surface, and we knew that the sun was just past the minimum of its eleven-year cycle of sunspot frequency. We did manage to obtain a number of clear photographs of sunspots using an Asahi Pentax 35 mm reflex camera coupled to a 3-1/2 inch diameter Questar telescope, but

not enough pictures of the same sunspot on consecutive days to deduce the solar rotation period. Library research turned up the following information for use when this project is continued in future years closer to sunspot maximum. Sunspots are not stationary on the surface of the sun, but have regular latitudinal and longitudinal components of motion due to the solar magnetic field, as well as a random motion component. The sun does not rotate as a solid body; its rotation is faster at the equator than at the poles. The best measurements of solar rotation rates are derived from observations of Doppler shifts of spectral lines measured at opposite sides of the solar disk.

### **Computer Graphic Simulations of Microscopic Particle Collisions for Determining Macroscopic Thermodynamics Along a Path; Part II**

Researcher: Midshipmen 1/C Devin P. Espindle, USN  
Adviser: Professor Murray S. Korman

The heat absorbed by an ideal monatomic gas during an isothermal expansion, when a piston slowly moves from volume point  $V_1$  to  $V_2$  in a cylinder, is a standard problem in thermodynamics. Students taking the SP226 Heat, Light and Sound course learn that the process involves an understanding of the kinetic energy loss that a gas molecule makes with the slowly moving piston "called the bunt", the drop in internal energy of the gas as a collection, which leads to a slight drop in temperature of the gas and the transfer of heat from the reservoir to the gas until an equilibrium temperature is

reached. This problem was modeled in two dimensions on a computer. The collisions involve  $N$  elastic scatterers that each have a cross-section of radius  $r_0$ . The heat reservoir is modeled by molecules having a random distribution of velocities at the wall boundary which is in contact with the gas. The piston is modeled as a wall which moves at the speed  $V_{wall}$ . Thermodynamic calculations involving work, heat and entropy are attempted for the model system. Adiabatic and free expansions are also simulated and compared with the well-known theoretical results. The work was

extended to cover collisions involving intermolecular potentials.

## Determination of Turbulent Vorticity by the Nonlinear Scattering of Crossed Ultrasonic Beams.

Researcher: Midshipman 1/C Richard Harrison, USN  
 Adviser: Professor Murray S. Korman

The nonlinear interaction of two, mutually perpendicular crossed ultrasonic beams, overlapping in the presence of turbulence, generates a scattered sum frequency component that radiates outside the interaction region. In the absence of turbulence, virtually no scattered sum frequency component exists (outside the interaction region). A theoretical investigation is reported which relates the shape of the ensembled averaged scattered sum frequency intensity spectrum,  $I_s(\omega, \theta_s)$ , (which exhibits a Doppler shift, frequency broadening, skewness and kurtosis) to the scattering angle  $\theta_s$ , incident and scattered wave vectors (where  $\mathbf{K}_s = \mathbf{k}_s - [\mathbf{k}_1 + \mathbf{k}_2]$ ) and statistical properties of the turbulent velocity field  $\mathbf{v}$ . The  $n$  spectral moments  $\langle (\mathbf{K}_s \cdot \mathbf{v})^n \rangle \propto \int I_s(\omega, \theta_s) (\omega - \langle \omega \rangle)^n d\omega$  (obtained from experiment) are used to evaluate turbulent velocity correlations like  $\langle v_x v_y \rangle$  where  $n = 2$ . The scattering geometry involves rotating the axes

of the transmitting crossed beams (which are always perpendicular to each other) in the plane containing the submerged circular water jet and receiver axes. Angle  $\theta_s$  is measured between the ray bisecting the transmitting axes and the stationary receiver axis. The crossed beams are focused and overlap at the common focal point. Spectral moments, obtained from scanning the overlap region across the jet, are used to predict velocity correlations across the width of the jet with good spatial resolution. When a second set of focused crossed beams is operated with an overlap region slightly displaced from the first set, one can measure the vorticity using information from the incident wave numbers  $\mathbf{k}_1, \mathbf{k}_2, \mathbf{k}_s, \mathbf{k}_i$  and two distinct nonlinear scattering directions that are denoted by  $\mathbf{k}_s$  and  $\mathbf{k}_i$ . Here, four distinct sum frequency components are involved.

## Development and Application of a Scanning Ion Microprobe

Researcher: Midshipmen 1/C Bernard Timothy Meehan, USN  
 Advisor: Jeffrey R. Vanhoy

A scanning ion microprobe was developed which can be used to produce one and two dimensional maps of elemental concentrations across the surface of a sample. An essential part of the microprobe is a software "instrument" that coordinates sample positioning, data acquisition, and storage of the x-ray spectra obtained. That instrument was developed using the Kmax<sup>®</sup> programming environment.

In order to evaluate the performance of the scanning ion microprobe, several data sets were acquired from samples with recognizable structure. First, a TEM grid with known grid spacing was used to measure the spatial resolution of the microprobe. The beam spot diameter on target was found to be approximately 30  $\mu\text{m}$ . The microprobe was then used to scan several different types of inclusions in the Allende meteorite. In the process, several interesting elemental correlations were found, and many programming errors and design flaws were discovered and corrected.

Automated procedures were developed to extract concentrations from large PIXE data sets using

the analysis program GUPIX. Although the GUPIX program was convenient to use, several deficiencies were discovered. Among the problems encountered were: the present data base restricts analysis to x-ray lines from elements heavier than sodium ( $Z=11$ ,  $K\alpha$  x-ray energy = 1.059 keV), the program apparently cannot achieve high quality fits for spectra with both low-atomic-number and high-atomic-number elements, possibly because it uses a fixed filter width for background removal, and the program did not treat special background situations such as the generation of spectral noise by secondary electron emission from the target.

Several methods to visualize the results were investigated, including a commercial software display package and several special-purpose, user-written routines. More development is needed to perform detailed quantitative analysis, because of the large amount of information contained in the spectra.

The completed scanning ion microprobe has greatly extended the capabilities of the Naval Academy Tandem Accelerator Laboratory and provided a rather

uncommon tool that will be applied to a variety of

elemental analysis concerns in the future.

## Publications

ELDER, S. A., Professor, co-author, "Fluid Physics for Oceanographers and Physicists," 2nd Ed. by S. A. Elder and J. Williams, currently being reviewed for publication by Butterworth/Heinemann, Oxford, UK

ENGLE, Irene M., Associate Professor, co-author, "Diurnal Variation of the Jovian Magnetosphere and Predicted Auroral Effects of the Comet SL9 Encounter," by Irene M. Engle, Todd D. Bode, René Prangé, and Sylvestre Maurice, *Bulletin of the American Physical Society* Volume 40, (April, 1995) p. 979

The solar wind interaction with the complex internal sources of magnetic field creates a magnetopause and attendant current structure for the planet Jupiter. The tilt of the magnetic axis relative to the spin axis and the rapid rate of spin (of period approximately 10 hours) led to predictions of a diurnally varying (length of day approximately 10 hours) magnetopause configuration.

The ephemeris of Comet SL9 en route to collision with Jupiter was such that the varying position of the magnetic angle regardless of the direction of the solar wind led to the possibility of each comet fragment potentially alternately crossing field lines opened to the interplanetary space and field lines closed on the planet surface as it approached near the South magnetic pole. This action had implications for possible intermittent anomalous auroral signatures, particularly in the Northern hemisphere of Jupiter.

ENGLE, Irene M., Associate Professor, "Comparison of Two Methods for Calculating Magnetic Multipole Moments," Technical Report NSWC-Carderock (Annapolis) June, 1995

It was desired to examine some possible causes of discrepancies in results of applying two methodologies to the calculation of multipole moments associated with a vessel as an extended source. The underlying theoretical equations were re-derived from basic principles and then compared with the original documentation to determine if any substantive errors existed in the published information. The computer programs based upon the theories were examined for evident programming errors. No substantive disagreements were found with the previously derived theory. No computer programming errors have as yet surfaced. However, in the process of deriving the

equations from basic principles, it was noted that the expansions used in the finite element method (FEM) depend very substantively upon the assumption of a "far-field" neighborhood for each of the terms in order to provide a reasonable functional representations of the sources the a fitting of magnetic field data. As the test data are generally taken in the "near-field" neighborhood within several boat-lengths of a vessel", disagreements are expected on this basis alone; when added to the independent uncertainties associated with the measurements, discrepancies on the order of 100% cannot be entirely ruled out, although order of magnitude agreement should be present in each case.

ERTEL, John P., Associate Professor, "Radiation Efficiency in Noise Control Engineering," by Joseph Dickey, G. Maidanik, and John P. Ertel, *The Proceedings of the International Noise Control Engineering Conference*, (Saint Petersburg, Russia), 5 October 1994.

The partial radiation efficiency of a surface on which the velocity spectral distribution is specified may be defined in terms of a ratio of integrals that are carried out over a wavenumber variable in a given direction. The partiality is in reference to this direction. The integrand in the numerator consists of the product of the absolute square of the velocity on the surface and the surface impedance of the semi-infinite fluid that fronts the surface. The integration in the numerator spans only the supersonic range. The integrand in the denominator consists merely of the absolute square of the velocity on the surface and the integration spans the entire wavenumber range. Spectral velocity distributions on the surface of fluid loaded regularly ribbed panels in response to line drivers are cited as examples. The methods and algorithms by which the partial radiation efficiency of line driven panels can be numerically evaluated are examined and discussed.

FONTANELLA, J. J., Professor, co-author, "High Pressure NMR and Electrical Conductivity Studies in Acid Form NAFION Membranes" by P.E. Stallworth, Assistant Professor, J. J. Fontanella, Professor and M. C. Wintersgill, Professor, *Electrochimica Acta*, 40 (1995) 309-313.

The effect of high pressure on the electrical conductivity and proton, deuteron and  $^{17}\text{O}$  NMR on an

acid form NAFION-117 conditioned at various levels of relative humidity has been determined. NMR measurements of T1 were carried out as a function of pressure up to 0.25 GPa. The complex impedance studies were made along the plane of the film at frequencies from 10 to 108 Hz at room temperature and pressures up to 0.3 GPa. The electrical conductivity and proton and deuteron NMR measurements show that the activation volume for materials containing greater than three water molecules per sulfonate is 2-3 cm<sup>3</sup> mol<sup>-1</sup> and larger values are found as the amount of water decreases. The implications of these results are discussed. The 17O NMR results are unexplained at the present time.

KORMAN, Murray S., Professor, Underwater Acoustics and Sonar, preliminary edition, Kendall/Hunt, Dubuque, Iowa, 1995 (245 pages including 175 figures).

KORMAN, Murray S., Professor, "Instrumentation to Generate a Two-phase Turbulent (Bubble) Submerged Water Jet for Flow Noise Measurements," J. Acoust. Soc. Am., 96, (1994), 3333.

It has been demonstrated that the near-field pressure spectrum (generated by a turbulent submerged water jet) is enhanced when the turbulent flow is modified to become a two-phase flow containing air bubbles. [Proceedings of the 14th ICA, Beijing, China, Acoustica 76, supplement to No. 4, May (1992), paper B6-1, p. 70.] An amplification factor  $G = \frac{\text{two-phase } df}{\text{single-phase } df}$  is measured as a function of the gross void fraction  $\phi$  of the air bubbles. Results showed that  $G \approx 2$  and  $G \approx 20$  at  $\phi = 0.0065$ . The range of void fraction was limited due to the use of the bubble maker (located at the jet nozzle entrance) which consisted of a fritted ceramic disk that was housed in a glass Buchner funnel and fed compressed nitrogen gas. It is possible to improve this apparatus by using carbonated water at high pressure in a nozzle that consists of an array of small holes in a thin circular plate. This arrangement can be controlled to yield small bubbles with an average diameter of about 100 microns in water. Larger void fractions are possible and the necessary constraint of having the resonant bubble frequencies well above the region of the low frequency flow noise spectrum (<500 Hz) is obtained. A brief video tape will be shown.

KORMAN, Murray S. Professor, co-author, "15 Minutes of Chaos," by Korman, Murray S. and Crum, Lawrence A., J. Acoust. Soc. Am., 97 35, (May 1995), 3302.

MONTGOMERY, Steven R., Associate Professor,

co-author, "Cooperative Photo refractive Beam Fanning in BaSrKNaNb5O15" by Steven R. Montgomery, Michael P. Gallagher, et. al., Journal of the Optical Society of America, B11, (September 94), 1694 - 1699.

A multiline laser beam incident upon a BSKNN crystal causes rings to form in the beam fan by means of cooperative photo refractive beam fanning between the different laser wavelengths. We examine the novel case in which the input beam consists of two lines from an argon ion laser with independently controlled linear polarizations as well as the single line case with equal amounts of ordinary and extraordinary light. We compute the expected rings in each case, taking full account of the crystal birefringence, and compare them with the experimental data. Applications of the rings to crystallography and cryptology are presented.

NOVO-GRADAC, A. D., Assistant Professor, co-author, "Role of Ion Pairs and Triples in Energy Transfer Up Conversion in YLiF4:Nd3+" by A. D. Novo-Gradac, W.M. Dennis, A. J. Silversmith, and W.M. Yen, in preparation.

STALLWORTH, P.E., Assistant Professor, co-author, "High Pressure NMR and Electrical Conductivity Studies in Acid Form Nafion Membranes", by R. S. Chen, P. E. Stallworth, S. G. Greenbaum, J. J. Fontanella and M. C. Wintersgill, Electrochimica Acta, 40, (1995), 309-313.

The effect of high pressure on the electrical conductivity and proton, deuteron and 17O NMR in acid form NAFION-117 conditioned at various levels of relative humidity has been determined. NMR measurements of T1 were carried out as a function of pressure up to 0.25 GPa. The complex impedance studies were made along the plane of the film at frequencies from 10 to 108 Hz at room temperature and pressures up to 0.3 GPa. The electrical conductivity and proton and deuteron NMR measurements show that the activation volume for materials containing greater than about three water molecules per sulfonate is 2-3 cm<sup>3</sup> mol<sup>-1</sup> and larger values are found as the amount of water decreases. The implications of these results are discussed. The 17O NMR results are unexplained at the present time.

STALLWORTH, P.E., Assistant Professor, co-author, "Sodium-23 NMR and Complex Impedance Studies of Gel Electrolytes Based On Poly(acrylonitrile)," by P. E. Stallworth, J. Li, S. G. Greenbaum, F. Croce, S. Slane and M. Salomon, Solid State Ionics, 73, (1994), 119-126.

Highly conducting gel electrolytes prepared from

mixtures of poly(acrylonitrile) (PAN), ethylene carbonate (EC), propylene carbonate (PC) and NaClO<sub>4</sub> have been studied by complex impedance, differential scanning calorimetry (DSC) and <sup>23</sup>Na nuclear magnetic resonance (NMR) spectroscopy. Ionic motional correlation times spanning nearly five orders of magnitude, probed by temperature-dependent dynamical features of the <sup>23</sup>Na quadrupole-broadened NMR lineshape, are strongly influenced by the single glass transition temperature observed in the gel electrolyte. Dielectric measurements of mixtures of PAN, EC and PC suggest that the polar nitrile group in PAN may interact with Na<sup>+</sup> ions in the gel. All results are consistent with the conclusion that PAN provides stability to the gel network down to the immediate vicinity of the Na<sup>+</sup> ions, rather than acting as a rigid framework for regions of liquid electrolyte.

TANKERSLEY, L. L., Professor, co-author, "Optical Debris Monitoring" by J. Reintjes, R. Mahon, M. D. Duncan, L. L. Tankersley, A. Schultz, V. C. Chen, D. J. Kover, P. L. Howard, M. Chamberlain, Srin Raghavan, and Naresh Gupta Laser Physics Branch, US Naval Research Laboratory.

We describe an on-line real-time oil debris monitor capable of detecting ferrous, non ferrous and non metallic debris in lubricating oil, hydraulic fluid and fuel. The monitor is based on optical imaging and

image processing and can be used to identify the severity and source of the fault through analysis of the morphology of the debris particles.

WINTERSGILL, M. C., Professor, co-author "High Pressure NMR and Electrical Conductivity Studies in Acid Form NAFION Membranes" by M. C. Wintersgill, P.E. Stallworth, Assistant Professor, and J. J. Fontanella, Professor, *Electrochimica Acta*, 40 (1995), 309-313.

The effect of high pressure on the electrical conductivity and proton, deuteron and <sup>17</sup>O NMR an acid form NAFION-117 conditioned at various levels of relative humidity has been determined. NMR measurements of T<sub>1</sub> were carried out as a function of pressure up to 0.25 GPa. The complex impedance studies were made along the plane of the film at frequencies from 10 to 108 Hz at room temperature and pressures up to 0.3 GPa. The electrical conductivity and proton and deuteron NMR measurements show that the activation volume for materials containing greater than three water molecules per sulfonate is 2-3 cm<sup>3</sup> mol<sup>-1</sup> and larger values are found as the amount of water decreases. The implications of these results are discussed. The <sup>17</sup>O NMR results are unexplained at the present time.

## Presentations

ANTHONY, J.M., Assistant Professor, "Irons are PeoElectple too," Kansas State University colloquium, Manhattan, Kansas, 7 July 1990

ANTHONY, J.M., Assistant Professor, "State Selected Single Electron Capture Processes in 3 to 8 MeV Collisions of C<sup>4+</sup> with H and He," Eleventh International Conference on the Applications of Accelerators in Research and Industry, Denton, Texas, 5-8 November 1990.

BRILL, Donald W. , Professor, "Electromagnetic Scattering from Finite-Length Cylinders and Rods," SPIE (the International Society for Optical Engineering) International Symposium on Aerospace/Defense Sensing & Control and Dual-Use Photonics, Orlando, Florida, 17-21 April 1995.

CORRELL, F.D., Professor, "PIXE Studies of Colonial Building Materials and Clay Smoking Pipes," 13th International Conference on the Applications of Accelerators to Research and Industry, Denton, Texas,

7 - 11 November, 1994.

CORRELL, F.D., Professor, co-author, "Development of a Scanning Ion Milliprobe," Midshipman 1/C B.T. Meehan, USN, F.D. Correll, and Associate Professor J.R. Vanhoy, SPS Session of the Southeastern Section Meeting of the American Physical Society, Newport News, Virginia, 10 - 12 November, 1994, .

ELDER, S.A. Professor, "Short Course on Acoustics ", Seminar presented before the Laryngeal Research Group, University of Maryland Medical Center, Baltimore Maryland, 22 May 1995.

ENGLE, I. M. Associate Professor, co-author, "Magnetospheres et Ionospheres du Systeme Solaire," by S. Maurice, M. Blanc, C.Z. Cheng and I. Engle, Presented by S. Maurice at the colloquium Magnetospheres et Ionospheres du Systeme Solaire, Toulouse, France, 21-23 Nov 1994 .

ENGLE, I. M. Associate Professor, co-author,

"Diurnally Varying Jovian Magnetosphere" by Ensign Todd D. Bode, USN, and Irene M. Engle Conference on the Magnetospheres of the Outer Planets made in Graz, Austria. 9 August, 1994.

ENGLE, I. M. Associate Professor, co-author, "Diurnal Variation of the Jovian Magnetosphere, and Predicted Auroral Effects of the Comet SL9 Encounter" by Irene M. Engle, Ensign Todd Bode, USN, Renée Prangé, and Sylvestre Maurice, Meeting of the American Physical Society, Washington, D.C., 19 April, 1995

ENGLE, I. M. Associate Professor, co-author, "Magnetic Mapping and Interpretation of Auroral Signatures of Comet SL9 in the Jovian Magnetosphere" by R. Prangé, I. Engle, M. Dunlop, M.K. Dougherty, S. Maurice, W. H. Ip, J.T. Clarke and G.E. Ballester European Astronomical Society Workshop on the Encounter of SL9 with Jupiter, Toulouse, France April, 1995.

ENGLE, I. M. Associate Professor, co-author, "Magnetic Mapping and Interpretation of Auroral Signatures of Comet SL9 in the Jovian Magnetosphere," by R. Prangé, I. Engle, M. Dunlop, M.K. Dougherty, S. Maurice, W. H. Ip, J.T. Clarke and G.E. Ballester Presented at the International Astronomical Workshop 156 SL9, Baltimore, Maryland, 11-12 May, 1995.

ENGLE, I. M. Associate Professor, "Mercury's Magnetosphere: Other Views," ESA Workshop on Mercury and Its Magnetosphere, London. England, 23 May, 1995.

ENGLE, I. M. Associate Professor, co-author, by S. Maurice, M. Blanc, C. Z. Cheng, E. Sittler, and I. Engle, "Construction d'Un Modèle Auto-cohérent de l'Equilibre des Magnétosphères de Jupiter et de Saturne." Pole National de Planétologie, Toulouse, France, 13-16 June, 1994.

ENGLE, I. M. Associate Professor, co-author, "Interaction of Saturn's Magnetosphere with the Solar Wind," by S. Maurice and I. Engle ESTEC, Noordwijk, the Netherlands, 15-19 May, 1995

ERTEL, John P. Associate Professor, "Interactive Physics II" Summer Meeting of the American Association of Physics Teacher, South Bend, Indiana, 7-13 August 1994.

ERTEL, John P. Associate Professor, "Interactive Physics II & Beyond" University of Maryland, Baltimore Campus, Catonsville, Maryland, 13 October 1994.

FONTANELLA, J. J., Professor, co-author, "Dielectric Relaxation, Charge Transport and Water Molecular Motion in Variable Molecular Weight NAFION Membranes: High Pressure Electrical Conductivity and NMR," by M.C. Wintersgill and J.J. Fontanella, Gordon Research Conference on Dielectrics, Holderness, New Hampshire, 31 July - 5 August, 1994.

FONTANELLA, J. J., Professor, co-author, "Dielectric Relaxation in Calcite and other Inorganics," by Professor M.C. Wintersgill and J.J. Fontanella, Gordon Research Conference on Dielectrics, Holderness, New Hampshire, 31 July - 5 August, 1994.

FONTANELLA, J. J., Professor, co-author, "Complex Impedance Studies of Ion Exchange Membranes," by Assistant Professor P.E. Stallworth and J.J. Fontanella, ONR Review of Electrochemical Sciences, Los Angeles, California, 13-15 July 1995.

HUDDLE, James R., Associate Professor, "The Coming Total Solar Eclipse in Aruba: What to Expect," 1998 Total Solar Eclipse Planning Session, Aruba, Netherlands Antilles, 30 Jul-3 Aug 1994.

KORMAN, Murray S. Professor, "Instrumentation to Generate a Two-phase Turbulent (Bubble) Submerged Water Jet for Flow Noise Measurements," 128th meeting of the Acoustical Society of America, Austin, Texas, 28 Nov- 2 Dec 1994.

KORMAN, Murray S. Professor, co-author, "15 Minutes of Chaos," by Murray S. Korman and Lawrence A. Crum, 129th Meeting of the Acoustical Society of America, Washington, DC, 30 May - 3 June 1995.

STALLWORTH, P. E., Assistant Professor, "Properties of Electrode Materials and Ion-Exchange Membranes," ONR Electrochemical Sciences Program Review, Los Angeles, California, 13-15 January 1995.

TANKERSLEY, L. L., Professor, co-author, "Optical Debris Monitoring," by J. Reintjes, R. Mahon, M. D. Duncan, L. L. Tankersley, A. Schultz, V. C. Chen, D. J. Kover, P. L. Howard, M. Chamberlain, Srin Raghavan, and Naresh Gupta, Machinery Failure Prevention Technology Meeting 49, Virginia Beach, Virginia April 1995 and at the Joint Oil Analysis Program, Pensacola, Florida, November 1994.

VANHOY, J.R., Associate Professor, co-author, "Electromagnetic Transition Rates Observed in the Stable Te Nuclei," by W. M. Faulkner, C. M. Davoren, Sally F. Hicks, J. R. Vanhoy, Texas Section Meeting of the American Physical Society, Huntsville, Texas, 2-4

March 95

VANHOY, J.R., Associate Professor, co-author, "Structural Characteristics of  $^{144}\text{Nd}$  Revealed by INS," by J.R. Vanhoy, Sally F. Hicks, C. M. Davoren, W. M. Faulkner, Southeastern Section Meeting of the American Physical Society, Newport News, Virginia, 10-12 November 1994.

VANHOY, J. R., Associate Professor, co-author, "Development of an Scanning Ion Milliprobe," by Midshipman 1/C B.T. Meehan, USN, Professor F.D. Correll, J.R. Vanhoy, SPS Session of the Southeastern Section Meeting of the American Physical Society, Newport News, Virginia, 10-12 November 1994.

WINTERSGILL, M. C., Professor, co-author, "Dielectric Relaxation, Charge Transport and Water Molecular Motion in Variable Molecular Weight NAFION Membranes: High Pressure Electrical Conductivity and NMR," by Professor J.J. Fontanella and M.C. Wintersgill, Gordon Research Conference on Dielectrics, Holderness, New Hampshire, 31 July - 5 August, 1994.

WINTERSGILL, M. C., Professor, co-author, "Dielectric Relaxation in Calcite and other Inorganics", by Professor J. J. Fontanella and M.C. Wintersgill, Gordon Research Conference on Dielectrics, Holderness, New Hampshire, 31 July - 5 August, 1994.

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# **Division of Professional Development**



# Leadership and Law

Commander Robert A. Gurczynski, USN  
Chair

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**M**embers of the Department of Leadership and Law continued research aimed at understanding officer development and its relation to midshipman behavior and subsequent performance in the active Naval Service. Research accomplished during the 1994-1995 academic year included: Dr. Karel Montor's continued analysis of the class of 1980, case studies of combat veterans, updates to the Ethics for the Junior Officer, and curriculum development research; Dr. Paul Roush's studies of practical curriculum development and further refinement of Myers-Briggs Type Indicator (MBTI) analysis and Values Survey analysis related to midshipman and officer performance; and Dr. James Barry's look at the possible interactive effects of religious commitment and personality profile on military leadership characteristics in the formation of military officer candidates, the extent of cooperation between University Counseling

Centers and their Chaplain counterparts, and the relationship of personality types and involvement in contact varsity sports to leadership skills of Marine Officers; Dr. Elizabeth Holmes' psychological autopsy research, eating disorder research, suicide prevention and post-suicide intervention in the Marine Corps, and research in the development of expertise; LCDR Alan Kaufman's and LT Brent Filbert's research in Naval Law as well as LT Filbert's research in the right against self-incrimination with regard to the EE investigation. The publications and presentations of the staff have further expanded the department's role in leading the Naval Service in matters dealing with leadership instruction and development, the prevention of eating disorders, suicide prevention, ethics, and military law, represent our commitment to providing every midshipman a Total Quality Education.

## Sponsored Research

### Retrospective and Historical Analysis of the USNA Class of 1980

Researcher: Professor Karel Montor  
Sponsor: Government Agency & USNA

During the Summer of 1976 the entire Class of 1980 had a Profile Analysis compiled consisting of 192 factors including neurological, psychological, and histological measurements as well as academic grades, military performance, and several other factors. Now,

20 years later, the predictive accuracy of various hypothesis are being compared against the actual performance of those measured. This is a three year study.

### Research and Development of Navy Combat Leadership Cases

Researchers: Professor Karel Montor, CDR Roger Coldiron, USN  
Sponsor: Naval Doctrine Command

Contacts are being made with those members of the Navy who have seen combat from an air, submarine, or surface ship standpoint. Their experiences are being

written up as cases studies for use in advanced Navy schools.

## **Ethics for the Junior Officer**

Researcher: Professor Karel Montor and Division of Professional Development Faculty

Sponsor: U.S. Naval Academy Class of 1964

Case research and update continue with the Class of 1995 receiving their copy on January 18, 1995 at a meeting addressed by the Under Secretary of the

Navy, Dr. Richard Danzig. The book is now also used in NROTC units, OCS, and the Coast Guard.

## **Prevalence of Disordered Eating Among Midshipmen**

Researcher: Commander Elizabeth Holmes, MSC, U.S. Navy and  
David Armstrong, III, PhD.

Sponsor: Commandant of Midshipmen

This epidemiological research protocol is to study disordered eating among midshipmen. The current midshipmen and academy plebes are surveyed. The Eating Disorder Inventory (EDI-2) has established reliability and validity for use among age and sex equivalent college populations. U. S. Naval Academy

(USNA) does not have objective data about the scope or severity of disordered eating or eating disorders. Research on disordered eating among midshipmen is necessary for the development of a scientific data base from which national policy can be formulated and effective intervention programs designed.

## **Suicide in the Marine Corps**

Researcher: Commander Elizabeth Holmes, MSC, U.S. Navy

Sponsor: Marine Forces Pacific and Naval Personnel Research and Development Command

A research protocol with 215 variables to investigate suicidal behavior was carried out within U.S. Marine Corps Forces stationed in the Pacific between 1991 and 1995. Completed suicide questionnaire surveys were analyzed revealing the first-ever scientific picture of the Marine who attempts or completes suicide. A voluntary control study questionnaire was sent to 1200 Marines and the final control group consisted of 399 completed questionnaires. The surveys provided

statistically valid data comparing Marines who attempted suicide, completed suicide, and the comparison group of non-attempting Marines. Results of multiple regression analysis and discriminate analysis revealed key factors which can be used to aid identification of potential suicide attempters and assist the Marine Corps in developing suicide policy, programs and services.

## **Post-Suicide Interventions**

Research: Commander Elizabeth K. Holmes, MSC, U.S. Navy

Sponsor: Marine Forces Pacific

A research investigation following a crisis intervention response was guided by a contingency plan developed in advance of the events as part of Marine Forces Pacific suicide prevention efforts. According to the Center for Disease Control Recommendations for a Community Plan for the Prevention and Containment of Suicide Clusters (CDC, 1988), the intervention plan should identify a coordinating group to manage responses to situations and plan an action response team. This plan was activated to respond to a series of traumatic deaths in Southern California which met the

criteria of suicide clusters. The crisis response was designed to contain this suicide cluster and to help young military adults at the work site effectively cope with feelings of loss and anger. Seven separate post-suicide interventions were conducted. The post-suicide intervention were to bring coworkers together for group support, cohesiveness, education about survivorship of suicide and assist in rebuilding group productivity and morale. This study had a one year follow-up in 1994 which revealed no further suicides for the next nine months and a Marine Corps savings in

excess of five million dollars.

## Independent Research

### Development of a Two-course Leadership Instructional Program

Researcher: Professor Karel Montor

A complete evaluation of the objective and accomplishments of the Academy's leadership instructional program was completed by the undersigned with guidance from the Superintendent

and Commandant along with counsel from Admiral Kinnaird R. McKee, USN (Ret.). The results have been incorporated into course materials that will be first presented in the Fall of 1995.

### Applications of Psychological Preferences in the Military

Researcher: Associate Professor Paul E. Roush

This is a continuation of a research project begun in July 1987. Purpose of the research is to assess how knowledge of psychological preferences can be used in the military in the many manifestations of "know yourself, know your people, know your job." The primary research instrument is the Myers-Briggs Type Indicator (MBTI). The effort thus far has resulted in more than fifteen thousand administrations of the instrument and development in conjunction with computer services of five computer programs for scoring the MBTI, accessing the data, and linking it to a wide range of variables. The study has included analysis of MBTI associations with leadership feedback, counseling feedback, transformational and transactional leadership, voluntary attrition, time management, preference stability over time, and accuracy of self-assessment. It has resulted to date in seven presentations; one at a leadership research conference at the University of Maryland, three at regional conferences and one at an international conference of the Association for Psychological Type, one at the institutional research conference of the service academies, and one at the bi-annual leadership conference of the Center for Creative Leadership. Thus

far, the project has resulted in the publication of articles in the Journal of Psychological Type, Military Psychology, Personnel Psychology and a chapter in an edited book, The Impact of Leadership. Leadership curricula and materials have been modified for the inclusion of MBTI theory and practice in two leadership courses taken by all midshipmen to increase their understanding of the meaning and importance of individual differences. During Academic year 1994-1995 midshipmen 3/c completed an expanded version of the MBTI, the Expanded Analysis Report (EAR), and received the interpretation during the new 3/c leadership course, NL202: Developing Subordinates. This marks the third year that the expanded version was integrated into the leadership curriculum. To date, presentations have been made locally to the faculties of three departments, English, Language Studies, and History in order to acquaint those faculty members with the use of the MBTI to account for differing learning styles as a function of type differences. Local programming support for the MBTI research project is provided by Julie Palmer in Computer Services.

### Enhanced Leadership Development

Researcher: Associate Professor Paul E. Roush

This project began in September 1987. Phase One of the research project involved development of NL301, a summer leadership course taken by all midshipmen. The course required each second classman to subject the plebe development program to a more rigorous and

systematic scrutiny than had been the case prior to NL301. The course injected planning into that process and served as a rational counterpoise to the traditional approach of simply requiring new plebes to repeat upperclassmen's plebe experiences. In another aspect

of NL301, class sessions were set aside for analysis by the midshipmen of very difficult problems facing the brigade. Midshipmen recommended solutions which, in turn, were screened, compiled, and forwarded for consideration by the Commandant. Phase Two of the project involved development of linkages between the classroom leadership work and the practical leadership experience in Bancroft Hall. Initially, that involved writing-projects which provided valuable feedback concerning the leadership experiences, from both the leaders' and the followers' perspectives. During academic year 1990-1991 the process was further expanded. The plebes used their personal computers to respond anonymously on three occasions to questions dealing with the leadership practices of the second classmen in their respective squads. On two occasions, after the upperclass had assessed themselves using the same criteria, the ratings supplied by the plebes were provided to the upperclass (in the form of aggregated data) as constructive feedback, during the second class leadership course in the spring semester. The feedback was the catalyst for significant changes in leadership behavior and in self-perception among many of the second classmen. This phase of the project yielded linkages between leadership feedback and the MBTI, and was the basis for two presentations in July 1991, one at the International Conference of the Association for Psychological Type and the second at the bi-annual research conference of the Center For Creative Leadership. Phase Three involved having the second

classmen in one of the six battalions receive different leadership instruction from that provided all the other battalions in the Spring 1991 semester. The special instruction emphasized a particular counseling approach, and required significant documentation of the counseling process as part of the course work. The second classmen involved were rated by the plebes as making significantly greater improvement in positive leadership practices than were the second classmen in the other battalions. That counseling program was instituted brigade-wide beginning in the 1991-1992 academic year. The leadership feedback program provided objective evidence that the fourth class perceived upperclass leadership in 1991-1992 as being more positive in all thirty-two categories than was the case a year earlier. In academic year 1992-1993 the positive trend continued. For the 1993-1994 and 1994-1995 academic years the results are less positive than in 1992-1993 but still more positive than in previous years. The evidence that leadership behavior changes in the direction of evaluative criteria following feedback from subordinates is very strong. The project this year yielded articles in Personnel Psychology and The Journal of Leadership Studies. Local programming support for the Leadership Feedback project was originally provided by then Lieutenant Blake Bush, USN, of the Professional Development Division. In an expanded version, the programming support is now under the auspices of Julie Palmer of Computer Services.

### Midshipmen Values Assessment

Researcher: Associate Professor Paul E. Roush

This research project involves having midshipmen respond on a survey about the values they hold. The survey began with the class of 1995. The survey is administered upon entry during the first week of plebe summer, upon completion of plebe summer, at the end of plebe year, and at the conclusion of each subsequent academic year. At the conclusion of Academic Year 1994-1995 the class of 1995 had taken the survey six times, the class of 1996 five times, the class of 1997 four times, and the class of 1998 three times. The class of 1995 thus became the first class that has completed the survey each year of its tenure at the Naval Academy. Results of the Values survey were briefed this year to the Commandant, the Academic Dean and Provost, and the Academic Assembly. The values

survey was developed by the Institutional Research Office at West Point and has been in use there for nearly two decades. The results of the survey administrations will enable us to assess the effectiveness of values inculcation during plebe summer and all of plebe year. In addition, we should be able to track the maturation of values as midshipmen progress through the four-year curriculum. Another potentially rich area for related research is correlational studies in which values are linked with a series of other variables. Finally, survey results are being compared with those at West Point to ascertain if changes follow the same pattern (are comparable in magnitude and direction) at both institutions.

## **Interactive Effects of Religious Commitment and Personality Profile in the Development of Successful Military Officer Trainees**

Researchers: Dr. James F. Barry and Sheila M. Barry

This study looked at possible relationships between religious commitment and personality profile (16PF) in the development of successful students at the Naval Academy. We looked at their involvement in religious activities, church services and their scores on the

16PF. The statistics indicated that there was no significant difference between the groups of religious and non-religious on measures of leadership, (the leadership subscale of the 16PF).

## **Chaplains' Evaluations of University Counseling Centers: "Would You Refer a Student?"**

Researchers: Dr. James F. Barry and Dr. Mike Moran

This study focuses on the relationship between Chaplain Centers and Counseling Centers. Do they, in fact, work together and refer students to each other's centers? They each have a mission of working with students to help these students overcome obstacles and hurdles that hinder their leadership potential in both the

civilian and military sectors of our society. Several hundred questionnaires have been sent out to Catholic and Protestant Chaplains at both public and private colleges and universities throughout the country. Data collection is in progress.

## **The Interactive Effects of Personality Type and Involvement in Contact Varsity Sports in the Development of Leadership Skills in Marine Officers**

Researcher: Dr. James F. Barry

This study is looking at the possible interactive effects between personality type, involvement in contact sports, and successful completion of field exercises at The Basic School at Quantico Virginia. I am working on this project with two Marine Captains who are instructors there. Their contention is that those officers who participated in contact sports do better in field

exercises. A second variable we will look at is personality type. Do certain personality types do better in field exercises where conditions are constantly changing than other personality types? I will have access to the MBTI types, the overall leadership grades of the students, and the grades that each student received in the field.

## **Psychological Autopsy**

Researcher: Commander Elizabeth K. Holmes, MSC, U.S. Navy

The psychological autopsy is a postmortem investigative tool that helps to ascertain the decedent's role in his own demise. Psychological autopsy reconstructs the deceased's background, personal relationships, habits, personality traits, and character. Reconstruction is accomplished by behavioral scientist through interviews with family, friends, coworkers and commands who are able to provide relevant information about the decedents' lifestyle, thoughts and emotions just prior to the death. Psychological autopsy

can be an aid to determining mode of death in equivocal deaths. The military conducts investigations after deaths, however, has not conducted review of these investigations, nor conducted psychological autopsies regarding suicides. This study used a behavioral scientist to review thirty suicides in the Marine Forces Pacific from 1992-1995. Results will assist investigating officers in preparing Judge Advocate General (JAG) Manual reports.

## **Development of Expertise**

Researcher: Commander Elizabeth K. Holmes, MSC, U.S. Navy

The Navy Doctrine Command's development of combat leadership doctrine required psychological support. This study will review the literature on the nature of expertise and how it is acquired. The review includes nonempirical and empirical literature. Empirical studies are drawn from professional education literature, cognitive psychology, medical training, athletic and game skills such as chess playing and artificial intelligence. Research on decision

making has two schools of thought one being behavioral and the other cognitive. Both perspectives are investigated. Behavioral decision theory emphasizes the performance of experts, cognitive science emphasizes differences, in expert's processes. Military professionals must define expertise and define the relationships between codified knowledge and experiences in the formation of combat leadership expertise.

## **Naval Law**

Researcher: Lieutenant Commander Alan G. Kaufman  
and Lieutenant Brent G. Filbert

The purpose of this research is to develop a textbook for midshipmen in the area of military naval law. The goal of the book is to provide midshipmen with the basics in military law in such a manner that is interesting and thought-provoking. The areas covered include: military investigations; history of military law; military crimes; government ethics; nonjudicial punishment; courts-martial; search and seizure; self-incrimination; apprehension and restraint;

environmental law; international law; law of the sea; law of armed conflict; prisoners of war; and war crimes. The research has included review of relevant military cases, statutes, regulations, law review articles, treaties and international agreements. Thus far, the chapter relating to government ethics has been completed and distributed to midshipmen in *Law for the Junior Officers*.

## **The Right Against Self Incrimination and the EE Investigation at the U.S. Naval Academy**

Researcher: Lieutenant Brent G. Filbert

This research focuses on whether the Navy violated the statutory self-incrimination rights of midshipmen involved in the EE investigation. The research reviewed the statutory language, legislative history, case law, and policy considerations relevant to this issue. Based on the research, a law article has been prepared and will be submitted for publication in

October 1994. The article concludes that the midshipmen should have been afforded their self-incrimination rights during the proceedings and that the reasoning used to justify the decision not to provide such rights was flawed.

## **Confinement on Bread and Water**

Researcher: Lieutenant Brent G. Filbert

The military still has the authority to award confinement on bread and water for personnel attached to or embarked in a vessel. However, the authority to award the punishment has been significantly restricted in the last few years. This research traces the history of confinement of bread and water, and addresses the utility and constitutionality of this most traditional of

naval punishments in today's military. The research on this subject has been completed and used for an article, "Man Can Live on Bread Alone: Why the Naval Service Needs to Protect its Most Unique (and Controversial) Punishment," which was submitted to the Naval Institute's magazine *Proceedings* in November 1995.

## Publications

ROUSH, Paul E., Associate Professor, Co-authors, Leanne Atwater, Arizona State University West, Allison Fischthal, State University of New York at Binghamton, "The Influence of Upward Feedback on Self- and Follower Ratings of Leadership," in *Personnel Psychology*, Vol 48 No 1 (Spring 1995) 35-59.

The impact of upward feedback (followers' perceptions of leadership provided to leaders) on leaders' self-evaluations and followers' subsequent ratings of leadership was assessed in a field setting. Subjects were 978 student leaders and their 1,232 followers. Results indicated that overall, leaders behaviors as rated by followers improved after feedback. Leaders self-evaluations following feedback became more similar to the evaluations provided by followers. Interestingly, when leaders were grouped according to whether feedback was positive, neutral or negative based on agreement between self- and follower ratings, differences between groups in post-feedback self-evaluations and follower ratings emerged. Self-evaluations for leaders receiving negative feedback (high self- relative to followers' ratings) went down, while self-evaluations for leaders receiving positive feedback (low self-evaluations relative to followers' ratings) went up. Follower ratings of leaders who received negative feedback improved following feedback to leaders, while there was no change in follower ratings for those receiving positive feedback. Implications for using upward feedback in organizations are discussed.

ROUSH, Paul E., Associate Professor, Co-author: Leanne Atwater, Arizona State University West, "An Investigation of Gender Effects on Followers' Ratings of Leaders, Leaders' Self-Ratings, and Reactions to Feedback," *The Journal of Leadership Studies* 1 (4), (1994) 37-52.

Consistent with stereotype-fit and rater/ratee congruence models, male followers rated female leaders lower than they rated male leaders. Male followers also rated female leaders lower than females rated females. Female followers did not rate females higher than they rated males. While the stereotype-fit and rater/ratee congruence models appeared to hold for males, they did not hold for females in this sample. As hypothesized, male and female leaders did not differ in their self-ratings of leadership made confidentially.

Contrary to hypotheses, females were not more likely than males to lower their self-ratings in response to negative feedback. Males and females also did not react differently to positive feedback.

HOLMES, Elizabeth K. PhD. and M. W. Parker, "Personality Characteristics of Patients with Temporomandibular Disorders: Diagnostic Implications," *Journal of Orofacial Pain*, Vol. 7, November 4, 1993, 337-344.

The chronic temporomandibular pain patient presents personality characteristics similar to other chronic pain patients when using the Minnesota Multiphasic Personality Inventory (MMPI). One hundred ten patients complaining of non-dental orofacial pain for longer than three months were diagnostically evaluated with the MMPI. Four distinct personality profiles were found: psychophysiological reaction, depressed reaction, defensive reaction, and "no diagnosis" (normal). The diagnostic and therapeutic implications of each profile are discussed in terms of a medical model of temporomandibular disorders.

FILBERT, Brent G., LT, JAGC and Alan G. Kaufman, LCDR, JAGC, "Law for the Junior Officer," Annapolis, Maryland: Kendall/Hunt Publishing Company, 1995.

Devoted to aspects of military law relevant to junior officers in the Navy and Marine Corps. This comprehensive text on military law; fundamentals of military justice; military offenses; criminal procedure; investigations; administrative law; government ethics; international law; law of the sea; war crimes; and rules of engagement. The text addresses these subjects by using military appellate and supreme court decisions, statutes, regulations and instructions. It poses frequent questions and issues designed to focus the student's attention on fundamental aspects of naval law, and to challenge the student's understanding of these concepts.

FILBERT, Brent G., LT, JAGC, "Article 107, Uniform Code of Military Justice: Not a License to Lie" *The Army Lawyer*, Charlottesville, Virginia, March 1994.

Examined judicially created limitations on the accountability of suspects charged with making false official statements in violation of Article 107 of the Uniform Code of Military Justice.

FILBERT, Brent G., LT, JAGC, "Failing the Test: The Naval Inspector's Role in the Naval Academy Cheating Scandal," *Naval Law Review*, Newport, Rhode Island, June 1995.

This article addresses the investigative procedures used by the Navy Inspector General during the Naval Academy cheating scandal. The focus of the article is on the failure to provide suspected midshipmen with the protections against self-incrimination contained in Article 31, UCMJ. The article contends that noncompliance with Article 31 on the basis that the

inquiry was administrative in nature was not justified either on legal or policy grounds. It also argues that the statute should apply in the broadest possible manner to all proceedings with a disciplinary character.

KAUFMAN, Alan G., LCDR, JAGC, "From the Sea, With Lawyers and Guns," pending publication with the *Naval Law Review*, Newport, Rhode Island.

Analyzed post-Cold War United States naval strategy as related to the international law of the sea governing naval operations in exclusive economic zones.

## Presentations

MONTOR, Karel, Professor, "The Teaching of Basic Leadership," Commandant, Academic Dean & Provost, Superintendent USNA throughout the Spring of 1995.

ROUSH, Paul E., Associate Professor, Interview on nationally televised cable news network, NewsTalk TV, on topic of sexual harassment and women in the military, Washington, D.C., 16 May 1995.

ROUSH, Paul E., Associate Professor, "Women at the Naval Academy: How Far Have they Come and Where are They Going?" Panel on Women in the U.S. Service Academies; Women's Research and Education Institute conference: "Women in the Military: Changes at Home, Lessons for Abroad, in War and Peacekeeping." Rayburn House Office Building, Washington, D.C., 2 December 1994.

ROUSH, Paul E., Associate Professor, "Truth-telling in the Relationships Between Leaders and Followers," Panel on the Individual and the Service: Truth and Consequences; 1994 Professional Ethics Conference, The Naval War College, Newport, RI, 14 November 1994.

HOLMES, Elizabeth K. PhD., "Anxiety and Personality in Dentistry," Naval Dental Clinic, Pearl Harbor, Hawaii, 27 January 1994.

HOLMES, Elizabeth K. PhD., "Dental Stress Management," Naval Dental Clinic, Pearl Harbor, Hawaii, 25 February 1994.

HOLMES, Elizabeth K. PhD., "Military Spouse Stressors," Navy Surface Officer's Wives Club, Hawaii, 1 March 1994.

HOLMES, Elizabeth K. PhD., "Suicide," CINCPACFLT Commander's Conference, Hawaii, 10 March 1994.

HOLMES, Elizabeth K. PhD., "Suicide in the Marine Forces," American Association of Suicidology, New York, New York, 9 April 1994.

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---

---

# Index of Contributors

## Faculty

- Ahmadi, S. , 11, 15, 17  
Albert, C. Elise , 213  
Andre, Peter P., 172, 186, 191  
Anthony, J.M., 221  
Anuta, M. , 180, 191, 193  
Appleby, David F., 106, 108  
Arbuthnot, Nancy, 100  
Armstrong, David III, 226  
Atangan, J.F.H. , 201, 205  
Avramov-Zamurovic, Svetlana , 72, 74, 81
- Bagaria, William J. , 2, 3, 4  
Bailey, Craig K. , 181, 191  
Baker, B. Mitchell, 187, 191  
Baker, Bradford W., 60, 61, 66  
Barry, James F. , 229  
Barry, Sheila M. , 229  
Barton, Oscar Jr., 4, 18, 23, 25, 29, 32, 39, 43  
Bastiaans, L. M. , 200  
Bechert , Thomas E. , 74  
Bledsoe, Penelope M. , 117, 118, 123, 128  
Bodnar, John W. , 143, 150, 154, 159  
Bonsignore, Joseph, 169  
Booth, Allyson , 94, 101, 104  
Bosshard, Marianne , 116, 118, 125, 126, 128  
Bowman, William R. , 85, 91  
Brill, Donald W., 207, 221  
Browne, Marlene , 95, 104  
Bruce, Ralph W. , 8, 12, 13, 16  
Bruninga, Robert E. , 5  
Buchanan, James L., 172, 187, 192  
Buckon, Andrew D. , 60, 64, 66, 67  
Butka, Brian K. , 12, 14  
Butler, Thomas W. , 18, 29, 54
- Calvert, Thomas E. , 60  
Campbell, Mark L. , 144, 150, 156, 159  
Campbell, William H. , 77, 78  
Carson, Bernard H. , 2, 5  
Cashman, Edward B. , 54  
Cassata, James R. , 47, 66  
Castro de Moux, Maria E. , 119, 126, 128  
Cerza, Martin , 47, 59, 66  
Chamberlain, Michael W. , 171, 173, 187, 189  
Cheek, Graham T. , 145, 151, 156, 157, 159  
Chi, Frank L.K. , 162
- Claridge, Laura, 104  
Clement, William I. , 72, 81  
Cochran, Charles , 131, 132, 133  
Cogar, William B. , 108  
Coldiron, Roger , 225  
Compton, Roger H. , 48, 57, 63, 64, 66, 68, 69, 71  
Cooper, Michael R. , 55  
Corredor, Eva L. , 119, 126, 128  
Correll, Francis D. , 207, 212, 213, 221  
Crane, Roger M. , 39, 40, 45  
Crawford, Carol G., 173, 187, 192  
Creuziger, Clementine , 116, 119, 120, 128  
Culham, Phyllis , 108  
Curtis, Willie, 136
- Davis, Gregory W. , 18, 19, 25, 29, 30, 32, 33, 43, 44  
Dawson, Thomas H. , 48, 62  
DeMoyer, Robert , 72  
Dickey, Joseph W. , 209  
Dillner, D.S., 201, 205  
Dillner, Debra K. , 145, 155  
Ding, L. , 211  
Doeff, M. , 211  
Doney, George D. , 81  
Drew, Anne Marie , 96, 101  
Dudley, Robert L. , 5  
Duncan, M. D. , 211  
Dwan, Terrence E. , 78, 81, 82  
D'Archangelo, James M. , 173, 192
- Edmondson, Charles A. , 214, 216  
Edsall, Douglas W. , 208  
Eisman, G.A. , 201, 205  
Eitelberg, Mark J. , 91  
Elder, Samuel A. , 214, 219, 221  
Elert, Mark , 146, 159  
Ellenberger, Nancy W. , 106, 111  
Engle, Irene M. , 208, 214, 216, 219, 221, 222  
Ertel, John P. , 209, 219, 222
- Farrell, Richard E. , 77, 79  
Ferrante, Robert F. , 146, 159  
Fetrow, Fred M. , 100, 104  
Filbert, Brent G. , 230, 231, 232  
Fitzgerald, Jeffrey P. , 151, 157  
Flack, Karen A. , 20, 26, 44

## CONTRIBUTORS

---

- Fleming, Bruce E, 101  
 Fletcher, William H. , 115, 121, 128  
 Floyd, Charles A., 79, 80  
 Foerster, John W. , 196, 200, 204  
 Fontanella , John J. , 160, 209, 211, 219, 222  
 Forsbacka, Matthew , 210  
 Foster, Christopher C. , 10, 13, 14  
 Fowler, Gary O. , 173  
 Frantzich, Stephen E. , 130, 131, 134, 137, 139, 140  
 Fredland, J. Eric , 85
- Gaglione, Anthony M., 192  
 Gaquin, Audrey , 118, 121, 122, 128  
 Garcia, Sonia Maria Fidelis , 174, 192  
 Gardner, Patrick D. , 78, 79, 80  
 Garman, Richard W. , 81, 82  
 Geer, I.W. , 200, 201, 203, 204, 206  
 Getter, Darryl E. , 87, 88  
 Gibb, Arthur, 93  
 Gillerlain, Joseph D. Jr., 20  
 Gillingham, David R. , 77, 78, 80  
 Gilmore, Elsa M. , 118, 122, 123, 127, 129  
 Ginger, K. M. , 200  
 Gomba, Frank J. , 147, 157  
 Goodman, Rae Jean B. , 84, 88, 93  
 Goodson, Earl F. , 76, 78, 79  
 Gordon, Dan , 2, 4  
 Granger, Robert A. , 26, 27, 30, 33, 34, 44  
 Grant, Caroline G. , 174, 187, 192  
 Greenbaum, S. , 211  
 Guarda, Sylvain , 123  
 Gunderson, C.R. , 202  
 Gunther, Wayne D. , 64  
 Gurczynski, Robert A. , 225  
 Guth, Peter L. , 197, 199, 201, 204, 205
- Haas, Bryan , 212  
 Hancock, John A. , 76, 77, 78  
 Harding, David S. , 9  
 Harff, Barbara , 134, 137, 138, 140  
 Harper, Mark J. , 48, 56, 57, 58, 60, 61, 64, 66, 67  
 Harrell, L. E. , 200  
 Harrison, Judith A. , 147, 148, 157, 160  
 Harrison, Patrick R. , 162, 163, 164, 165, 166, 169  
 Hasson, Dennis F. , 20, 35, 44  
 Hawley, J. Gary, 61  
 Hein, John , 22, 23  
 Herrmann, Robert A. , 174, 181, 182, 187, 188, 192  
 Heuer, William B. , 148, 152, 160  
 Hicks, Sally F. , 212  
 Hill, John M., 102, 104  
 Hoffman, Michael, 188, 192  
 Holiway, C. E., 201  
 Holmes, Elizabeth , 226, 229, 230, 231, 232  
 Howes, Cory, 81
- Huddle, James R. , 215, 217, 222  
 Hutchins, John , 115
- Izat, P. , 178
- Jason, Philip K. , 96, 102, 104  
 Jensen, Christopher H. , 78, 79, 80  
 Johnson, Bruce, 61  
 Johnson, David Copeland , 184  
 Johnston, Eileen , 95, 96, 97  
 Johnston, J. P., 44  
 Jones, D.W. , 201, 205  
 Jones, M. K., 202  
 Joyce, James A. , 21, 30, 35, 44  
 Joyner, W. David , 181
- Kammeyer, Janet Whalen , 182, 192  
 Kaplan, Harold M., 192  
 Karpouzian, Gabriel N. , 2, 4, 6, 7  
 Kaufman, Alan G. , 230, 231, 232  
 Kendrick, James F. , 8  
 Keye, Duane G. , 9  
 Kinter, Christopher M. , 148, 157  
 Kirsch, Barry J., 190  
 Kline, R. P., 187  
 Knauss, Donald T. , 81  
 Knowles, Kenneth A. , 12, 72, 75  
 Knutson, Elizabeth M. , 116, 118, 123, 124, 127, 129  
 Koester, G. J. , 200  
 Kolp, John G., 106  
 Konkowski, Deborah A. , 175, 188, 192  
 Korman, Murray S. , 210, 217, 218, 220, 222  
 Korzeniowski, Kelly A. , 9, 12, 14, 15, 17  
 Koubek, Edward , 155, 160  
 Krayner, W.A. , 200  
 Kriebel, David L. , 48, 49, 62, 66  
 Kruger, J., 36, 37, 38  
 Kulchicky, Ksenia M. , 85  
 Kurantsin-Mills, Joseph , 82  
 Kwiatek, Sandra , 22
- Lamb, Karl, 138  
 Langan, Thomas J. , 50  
 Lee, H. L. , 30, 31, 32  
 Lee, Raymond , 195, 200, 204  
 Lillard, R.S., 36, 37  
 Lim, Tian S., 15, 17  
 Lind, Charles , 6  
 Lindler, Keith W. , 48, 58, 62, 64, 66  
 Link, R. E., 35  
 Little, Roger D. , 85, 90, 91, 93  
 Loew, Murray H., 82  
 Lomax, Joseph F., 160  
 Long, Peter F. , 175, 185  
 Lopardo, V. J., 36

## CONTRIBUTORS

- 
- Love, Robert W. Jr., 106, 110, 112, 113  
 Lozier, D. W. , 180, 191, 193, 194  
 Lundestedt, Carl , 212  
  
 Ma, Y. , 211  
 MacDonald, A. E. , 201  
 Mace, Nancy A. , 97, 102, 104  
 Mackney, Michael D. A. , 3, 6  
 Madeka, Frank , 19, 33, 44  
 Madison, Robert D. , 98, 102, 104  
 Mahar, Thomas J. , 183  
 Maidanik, Gideon , 209  
 Makela, Michael , 22  
 Malek-Madani, Reza, ii, 23, 175, 188, 189, 192, 193, 202, 203  
 Mallory, Bill , 30  
 Malone, Eloise , 131, 132, 138, 140  
 Maloney, Dennis A. , 76, 77, 78  
 Martin, R. E. III, 181  
 Martin, Richard L. , 22  
 Martinek, C.A. , 195, 201, 203, 205, 206  
 Maruszewski, Richard F. Jr., 193  
 Masterson, Daniel , 109, 111, 112, 113  
 Matkins, J. J. , 200  
 Mayer, Robert H. , 50, 61, 62  
 McArdle, Peter , 2, 4  
 McClean, Roy E. , 149, 158, 160  
 McClelland, Charles B. , 78, 79, 80  
 McCormick, Michael E., 62, 63  
 McCoy, Peter A., 189, 193  
 McKenney, Timothy L., 63, 66  
 McManus, D.E. , 203, 206  
 McShane, Janet , 176  
 Mechtel, Deborah , 11  
 Mehta, R. N. , 66  
 Mette, James A. , 46  
 Meyerson, Mark D. , 176, 187, 189  
 Michael, T. S. , 176, 189, 193  
 Middleton, R.D. , 201, 205  
 Mierwicki, Greg , 30  
 Miller, E.J. , 201, 205  
 Millett, Marshall G. , 51  
 Milman, P. , 187  
 Miner, Steven M. , 21, 44  
 Misra, M. , 66  
 Mitchell, E. Eugene , 75, 81, 82  
 Mohr, Thomas, 22  
 Montgomery, Steven R. , 210, 220  
 Montor, Karel , 225, 226, 227, 232  
 Moran, Angela , 22, 36, 44  
 Moran, J. M. , 200  
 Moran, Mike , 229  
 Moran, Patrick J. , 22, 23, 30, 31, 32, 36, 37, 38, 44  
 Morris, Clair , 88, 92  
 Moulis, E. John , 183  
  
 Mouring, Sarah E. , 51, 52, 54, 56, 59, 62, 63, 66  
 Mullen, Caitlin P., 204, 205  
 Mulvany, J. P. , 200  
 Myojin, Chiyo , 117, 127  
  
 Nakos, George , 176, 184  
 Natishan, Paul , 22  
 Navratil, Joseph S., , 104  
 Nehrling, Bruce C. , 48, 63, 64, 66  
 Nelson, Martin E. , 46, 51, 52, 54, 55, 56, 58, 59, 60, 61, 64, 66, 67  
 Nelson, Samuel , 109, 112, 113  
 Newcomb, Robert W. , 11, 15, 16, 17  
 Nolan, Charles J. Jr., 98, 103, 104  
 Novo-Gradac, A. D., 220  
 Nuckols, M. L. , 52, 53, 65  
  
 O'Brien, Timothy D. , 98, 103  
 O'Mara, Duncan F. , 76, 77, 80  
  
 Pace, P. E. , 14  
 Palazotto, A. N., 38, 39  
 Palmer, Sheila C. , 27, 28, 44  
 Park, Eun K., 166, 167, 169  
 Parker, M. W. , 231  
 Parker, Michael P. , 94, 95, 98, 99, 103  
 Passow, M. J. , 200  
 Pearson, Wayne H. , 152, 155, 158, 160  
 Peeler, David P. , 109, 113  
 Penn, Howard L. , 177, 193  
 Perez, Manuel A., 167, 169  
 Perry, Martin D. Jr., 147  
 Phillips, Andrew T. , 163, 165, 168, 169, 170  
 Pierce, John F., 189, 193  
 Piper, George E. , 73, 81, 82  
 Preyer, J. A., 203  
 Price, Geoffrey L. , 177, 178  
 Pruitt, Beth L. , 55  
 Pruner, Ludmila Z. , 124, 127, 129  
 Purkitt, Helen E. , 134, 135, 138, 140  
  
 Quartararo, Anne T. , 109, 112, 113  
  
 Rachwald, Arthur , 131, 132, 135, 136, 138, 140, 141  
 Raouf, Raouf A. , 18, 23, 28, 32, 38, 39, 44  
 Rask, Olaf N. , 79, 80  
 Ratcliffe, Colin P. , 23, 24, 28, 39, 40, 45  
 Rau, Robert , 131, 136, 139  
 Reiss, Robert , 32  
 Reitan, Paula J. , 164  
 Richter, R. Bruce , 184  
 Rivera-La Scala, Gladys M. , 125  
 Roberts, William R. , 110  
 Rogers, David F, 7  
 Rosenthal, M.A., 200

## CONTRIBUTORS

---

- Roush, Paul E. , 227, 228, 231, 232  
Ruenzel, Stephanie, 104  
Rydell, N. N. , 201
- Saarlas, Maida, 2  
Saez-Ortiz, Ricardo , 64  
Sanders, Thomas J. , 178, 185  
Sanford, W. , 200  
Santiago, Armando L. , 39, 40  
Santoro, R. P., 15  
Sarkady, Antal A. , 10, 13, 16  
Scanlon, J.F., 37, 38  
Schoenthal, Gerhard S. , 212  
Schultz, John W. , 160  
Schulze, Kay G. , 164, 168, 170  
Sellami, Louiza , 11, 15, 16, 17  
Shade, Joyce E. , 152, 153, 158, 160  
Shaughnessy, James J., 70  
Shelby, Robert N. , 211  
Shifler, D.A., 36, 37  
Siatkowski, Ronald E., 161  
Sills, Clarence F. Jr, 106, 110, 111, 114  
Smart, Scott D., 204  
Smith, B. , 200  
Smith, David , 196, 198, 200, 201, 202, 203, 204, 205, 206  
Smith, Donald S. , 78, 79, 80  
Smith, P. J. , 201  
Smith, P. L. K. , 203  
Smith, Russell A. , 18  
Snow, J. T. , 200, 201  
Spangler, T. C. , 201  
Stallworth, Phillip E. , 211, 216, 220, 222  
Streniz, C.C., 36  
Strong, Alan E. , 197, 199, 201, 205, 206  
Sun, Yumei , 115
- Tait, W.S., 37  
Tangorra, James L. , 77, 79, 80  
Tankersley, Lawrence L. , 211, 221, 222  
Thierfelder, Karen E. , 86, 87, 88, 89, 90, 92, 93  
Thompson, Larry V. , 110, 111  
Thomson, John M, 104  
Thurman, Katie P., 190  
Thurman, Paul E. , 76, 78, 79
- Tinsley, Molly , 99  
Tomlinson, David , 99, 103, 104  
Tomlinson, Rodney G. , 133, 139  
Treacy, Donald J. , 207  
Tucker, Ernest , 107, 113, 114  
Turisco, JoAnn S. , 184  
Turner, Peter R., 179, 180, 186, 190, 191, 193, 194  
Turner, John , 178  
Tuttle, Kenneth L. , 53, 55, 56, 60, 67
- Urbach, Herman B., 81, 82  
Urban, Joseph J. , 149, 150, 159, 161
- Vanhoy, Jeffrey R. , 212, 218, 222, 223  
Vieira, Mario , 197, 201, 204, 205, 206  
Vining, Pierre G. , 61  
Visco, S. , 211  
Voros, Sharon Dahlgren , 115, 125, 128, 129
- Waite, Boyd A. , 143, 161  
Wallendorf, Louise A. , 48, 71  
Wardlaw, William P. , 184, 185, 191, 194  
Warthan, H. P. , 201  
Waters, Jennifer K. , 49, 53  
Watt, Anne E., 168, 170  
Watts, Jerry W. , 81, 82  
Weinbeck, R. S. , 200, 201  
White, G. J. , 18, 54, 59  
Wick, Carl E. , 73, 74, 82  
Wiggins, Peter F. , 61  
Williams, Leroy G. , 162, 169, 170  
Williams, Robert , 176  
Wintersgill, Mary C. , 160, 209, 213, 221, 223  
Withers, Wm. Douglas, 185  
Wooten, John , 100  
Wu, Chih , 25, 33, 36, 41, 42, 43
- Yates, S.W. , 212  
Yu, Maochun , 107, 113, 114
- Zak, Thomas A. , 88, 91  
Zotti, Priscilla , 132  
Zseleczky, John J., 70, 71

## Midshipmen

- Aboul-Seoud, Khaled , 76  
Alevorio, Alessandro V. , 76  
Anderson, Jon M., 76  
Andrews, Theodore J. , 76
- Armas, Matthew J. , 76  
Artery, Brad , 196, 202  
Avens, Corey M. , 76

## CONTRIBUTORS

---

- Baca, Marc X. , 76  
 Baker, Bradford W. , 56  
 Baker, Erik R. , 76  
 Baker, Michael L. , 110  
 Bandy, Robert C. , 77  
 Basham, Charles J. , 77  
 Bates, James A. Jr., 77  
 Bellack, Steven J. , 77  
 Benedict, Brian H. , 212  
 Blastos, Basil A. , 77  
 Boaz, Jeffrey L. , 29, 30  
 Bocanegra, Stephen L. , 77  
 Boles, Sean P. , 4, 29  
 Brandt, Jason K. , 77  
 Brosnan, Timothy M. , 77  
 Brown, James E. , 158  
 Burke, David , 133  
 Burkholder, Jason O. , 77  
 Busch, Bradley W. , 12  
 Butler, James , 110
- Campbell, Douglas C. , 91  
 Canales, Christopher H. , 77  
 Carlson, Andrew F. , 77  
 Cary, Angelique L. , 77  
 Clark, Brian J. , 77  
 Croci, P. , 32  
 Curry, Robert D. , 77
- Davies, Michael B. , 77  
 Deciechi, Daniel N. , 5  
 Devos, Daniel A. , 78  
 Dillon, James W. , 90  
 Donald, Bruce J. , 56  
 Doney, Kevin T. , 78  
 Down, John J. , 78  
 Drayton, Scott , 30, 31  
 Duff, D. Gavin , 57
- Eby, Matthew , 134  
 Emery, Greg K. , 199, 206  
 Espindle, Devin P. , 217
- Faehnle, David J. , 2, 5  
 Farrell, Dennis L. , 78  
 Fink, Todd C. , 77  
 Fionda, K. Quinn , 136  
 Frey, Jonathon E. , 78  
 Froehner, J. , 29  
 Frontera, Paul J. , 74  
 Fujimoto, Sean D. , 78
- Gallagher, Patrick J. , 78  
 Garcia, Jorge F. , 217  
 George, Donald L. , 76
- Gillen, Zachary K. , 75  
 Gnau, Andrew P. , 77  
 Gonzalez, Anthony R. , 77  
 Goode, Christy J. , 198  
 Goodwin, Robert H. , 150  
 Grzymalski, Kenneth W. , 78
- Hamstra, Eric J. , 78  
 Harrison, Richard , 218  
 Harter, James S. S. , 144  
 Hassenger, Mike , 133  
 Hayes, Eric , 31, 32  
 Heidsieck, Jeffrey L. , 78  
 Henneberg, Thomas W. , 78  
 Herman, Daniel A. , 77  
 Hildebrandt, Wesley A. , ii, 165, 186  
 Hines, Megan Kathleen , 185  
 Hingst, Michael , 164  
 Holman, Daniel J. , 76  
 Hopper, John , 31  
 Horn, Michael , 216  
 Howard, Michael J. , 77  
 Hurst, Jonathan R. , 77  
 Hutchison, Amy , 198
- Jenkins, David T. , 78  
 Jensen, Poul , 134  
 Jiong, Foo S. , 73  
 Jones, Katie M. , 198  
 Joseph, Garrick M. , 78
- Kawas, Matthew J., 12, 75  
 Kelinman, Aaron E. , 78  
 King, Michael F. , 13  
 Kirsch, Jon R. , 78  
 Klein, Dennis , 59, 110  
 Klemeyer, Robert W. , 79  
 Kline, Brigand W. , 79  
 Knowles, Brian S. , 79  
 Ko, Joong S. , 57  
 Kremier, Scott , 135  
 Kuyler, Raphael P. , 111
- Lamas, Ramon , 111  
 Lambert, Mike , 186, 193  
 Lapaglia, Michael C. , 12  
 Law, David A. , 79  
 Lawson, Richard B., 57, 69, 71  
 Limbert, Matthew E. , 79  
 Lindoerfer, Brian T. , 79  
 Lyssy, Gordon J. , 79
- Magee, Caroline E. , 100  
 Mahelona, Ryan K. , 78  
 Mahofski, Ronnie E. , 79

## CONTRIBUTORS

---

Malatesta, Daniel P. , 79  
Maruna, David , 111  
McElmurray, Brannen G. , 73  
McGarity, Michael C. , 79  
McHenry, Robert S. , 58, 66  
Meehan, Bernard T. , 212, 218  
Miller, Kyle A. , 79  
Miller, Scott , 154  
Morgan, Grayson B. , 79  
Mui, John , 79  
Murphy, Krista , 79  
Murphy, Matthew W. , 79  
Muth, Sean M. , 58

Nave, Mark W. , 80

Parsons, Jeffrey B. , 80  
Patterson, James N. , 78  
Paulson, Erik J. , 80  
Pavlyak, Gregory K. , 80  
Peck, Brian J. , 80  
Pelczar, Andrew , 154  
Phelan, John T. , 76  
Phul, Anil , 79  
Piper, Ross H. III , 78  
Price, Joshua , 29  
Pritchell, William C. , 80

Richardson, David K. , 79  
Ritz, Jason E. , 77  
Rodriguez, Raymond Y. , 77  
Rosen, Bradley N. , 136  
Roth, Jarret L. , 76

Sager, Joshua A. , 79  
Santacruz, Raymond A. , 77  
Santini, Michael R. , 59  
Scoonover, Elizabeth , 5  
Scott, Adam T. , 79  
Seen, Matthew A. , 5  
Shapiro, Boris , 135  
Shell, James D. , 59  
Silas Ahn, So Won , 30

Skubis, Mark , 216  
Smith, Christopher L. , 80  
Smith, Robert W. , 76  
Smith, Scott P. , 77  
Spooner, Michael , 155  
Stenzel, Eric A. , 80  
Still, Aaron M. , 74  
Stone, Ryan M. , 74  
Strickland, John A. , 80  
Stripinis, Jason M. , 80  
Studt, Randy L. , 78  
Swanson, Brian D. , 78

Taff, William R. , 80  
Tansky, Eric W. , 76  
Tarsa, Christopher J. , 80  
Tewell, Ryan T. , 74  
Thiry, Paul D. , 77  
Tolerba, Benjamin P. , 76  
Tom, Ward Y. , 80  
Townsend, Kevin , 155  
Trujillo, David M. , 80  
Tschampl, Rebecca L. , 77

Ventura, John , 210  
Viayra, R. Michael , 155  
Vroman, Robert H. , 59

Wagner, Erich , 111  
Weller, Christopher S. , 80  
West, Jay , 90  
Whitlock, Richard W. , 60  
Wick, Karl W. , 77  
Williscroft, Jason G. , 75, 80  
Wingeart, Paul H. , 134  
Winter, Timothy M. , 199, 206  
Wolf, Robert A. , 76  
Wynns, Paul L. , 6

Zeigler, Glenn M. , 80  
Zima, Gregory N. , 78

---

---

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